Aviation Week and Space Technology

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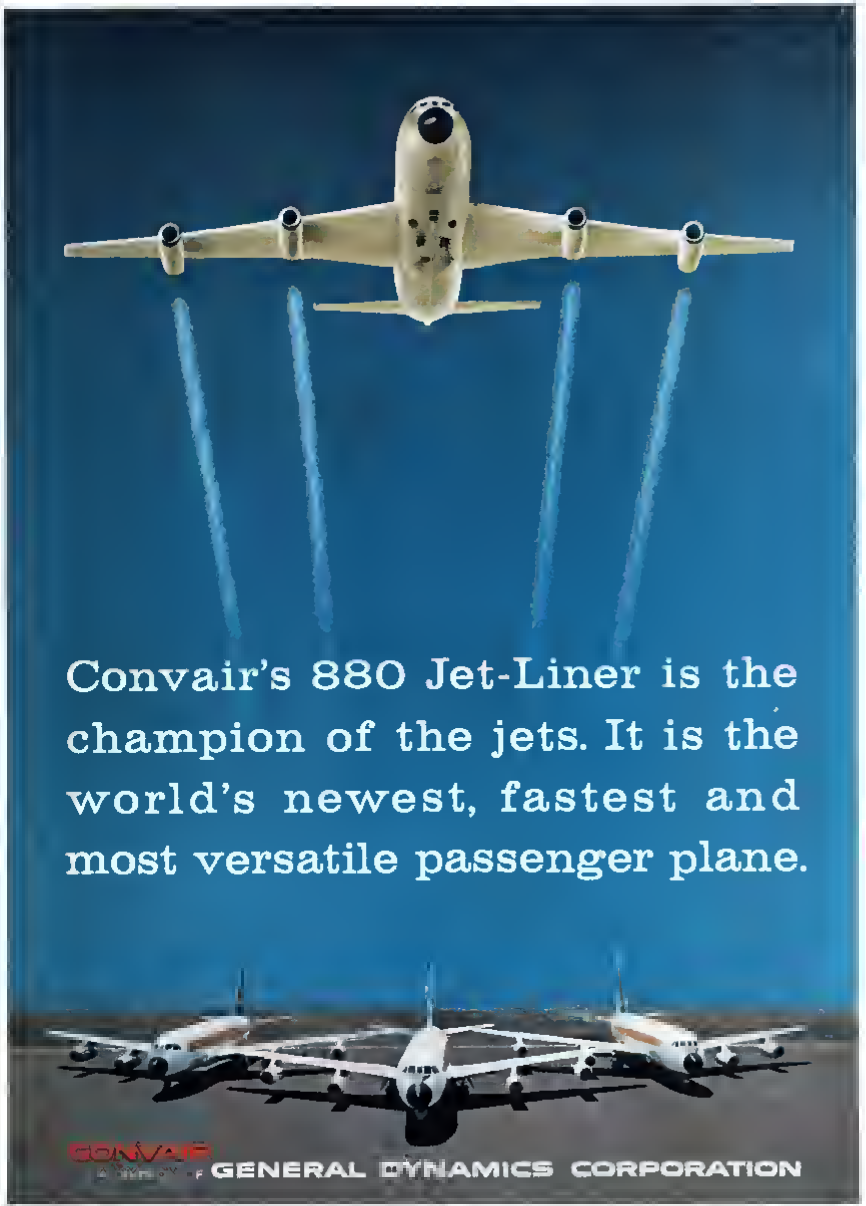
April 4, 1960

Pilot Report On Douglas DC-8 Transport

Arma Inertial Guidance Tested in Convair Atlas



First to offer [illegible] jets for 800 Jet Liners [illegible] will be TWA DELTA REAL AEROVIAS (Brazil) SAS SWISSAIR AMERICAN CAT (Formosa) CAPITAL AVENSA (Venezuela)

VICKERS ECM COOLING SYSTEM plus

3M's FC-75 dissipates 47 kw input in 74 lb package

Vickers' 38 years of specializing in handling of fluids has been directed to "application-tailored" airborne cooling systems — reliable systems that are light weight and feature a broad range of flow and pressure characteristics

This typical Vickers system circulates Minnesota Mining and Manufacturing Co 's heat dissipating dielectric coolant, FC-75, through Sperry's advanced design electronic countermeasures system

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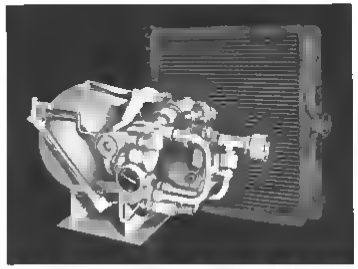
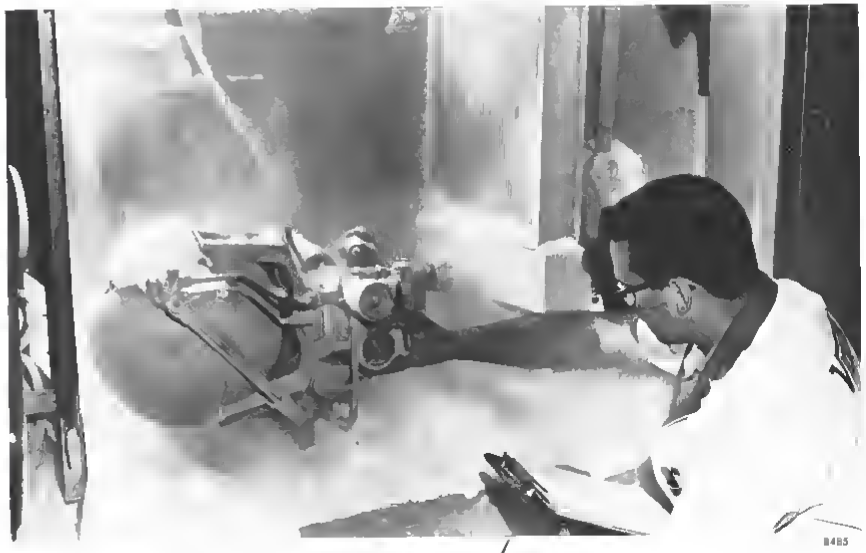
Write for Bulletin A-5244 for more details.



PUMPING UNIT AND CORE Large airborne cooling system developed by Vickers' Aero Hydraulic Products division makes efficient use of 3M's FC-75 dielectric coolant to dissipate heat from electronic countermeasures equipment. Output pressure is required to be approximately 100 psi with fluid flow rates as high as 52 gpm Operating range is from —65 F to 210 F Pumping unit weighs 54 lb. dry and the heat exchanger core only an additional 20 lb Shown below as part of the extensive testing program conducted by Vickers to prove out the new design It included extremes of heat and cold as well as vibration shock attitude and other physical tests.



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AVIATION CALENDAR

Apr. 11-13—Electrical Engineering in Space Technology. Hotel Baker, Dallas, Tex. Sponsor: American Institute of Electrical Engineers.

Apr. 12-13—14th Annual Spring Technical Conference. Institute of Radio Engineers in conjunction with the American Rocket Society. Hotel Alms, Cincinnati, Ohio.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems. New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn, Department of Defense Research Agencies, Institute of Radio Engineers.

Apr. 19-21—10th Annual Convention, International Airline Navigators Council. Hotel Manhattan, New York, N. Y.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA, the Rand Corp.

Apr. 21—Annual Eastern Regional Meeting, Institute of Navigation. Key Bridge Marriott Motor Hotel, Washington, D. C.

Apr. 21-22—Southwest Metals & Minerals Conference. "Metals and Materials for the Space Age." American Institute of Mining, Metallurgical and Petroleum Engineers. Ambassador Hotel, Los Angeles.

Apr. 21-22—Seventh Annual Heat Transfer Conference. "A Survey of Radiation Phenomena and Heat Transfer Equipment for Space Flight Application." Oklahoma State University, Stillwater, Okla.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

Apr. 28-29—18th Annual Meeting, Aeronautical Training Society. Mayflower Hotel, Washington, D. C.

Apr. 28-29—Regional Quarterly Meeting, Assn. of Local Transport Airlines, Warwick Hotel, Philadelphia, Pa.

(Continued on page 6)

AVIATION WEEK and Space Technology

April 4, 1960

Vol. 72 No. 14

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AVIATION CALENDAR

(Continued from page 5)

Apr. 28-29—Symposium on "Closed Circuit Respiratory Systems," Wright Air Development Division, Wright Patterson AFB

May 2-4—National Aeronautical Electronics Conference, Biltmore and Miami Pick Hotels, Dayton, Ohio. Sponsor: Institute of Radio Engineers

May 2-5—Sixth National Flight Test Symposium, Instrument Society of America, San Diego, Calif.

May 3-5—Fourth Signal Maintenance Symposium, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego

May 9-12—Semi-Annual Meeting and Astronautical Exposition, American Rocket Society, Ambassador Hotel, Los Angeles

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton-Dallas Hotel and State Fair Park, Dallas, Tex.

May 9-13—Annual Conference, Society of Photographic Scientists and Engineers, Miramar Hotel, Los Angeles, Calif.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts, American Institute of Electrical Engineers, Electronic Industries Assn., Western Electronic Manufacturers Assn.

May 11-14—16th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 13-14—1960 National Intercollegiate Flying Meet, Ohio State University Airport, Columbus, Ohio

May 15-18—Annual Convention and Business Meeting, American Assn. of Airport Executives, Waldorf-Astoria, New York

May 16-20—Aviation Fire Safety Seminar, National Fire Protection Assn., Queen Elizabeth Hotel, Montreal, Canada

May 18-20—National Meeting, Society for Experimental Stress Analysis, Hotel Severin, Indianapolis, Ind. Theme: Stress Analysis of Propulsion Systems

May 22-29—Fourth Annual Reserve Navigation Competition, Ellington AFB, Tex.

May 23-25—12th Annual Meeting, German Society for Rocket Engineering and Space Flight Research, Heidelberg, West Germany

May 24-26—1960 Convention, American Society for Quality Control, San Francisco, Calif.

May 26-27—Psychophysiological Aspects of Space Flight" Symposium, Hilton Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine, USAF Aero-Space Medical Center (ATC), and arranged by Southwest Research Institute. Unclassified, but by invitation.

Aug. 15-20—11th Annual Congress International Astronautical Federation, Royal Institute of Technology, Stockholm

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 12-16—16th Annual General Meeting, International Air Transport Assn., Copenhagen, Denmark

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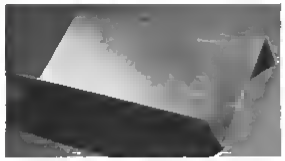

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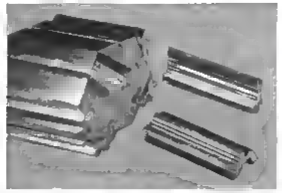

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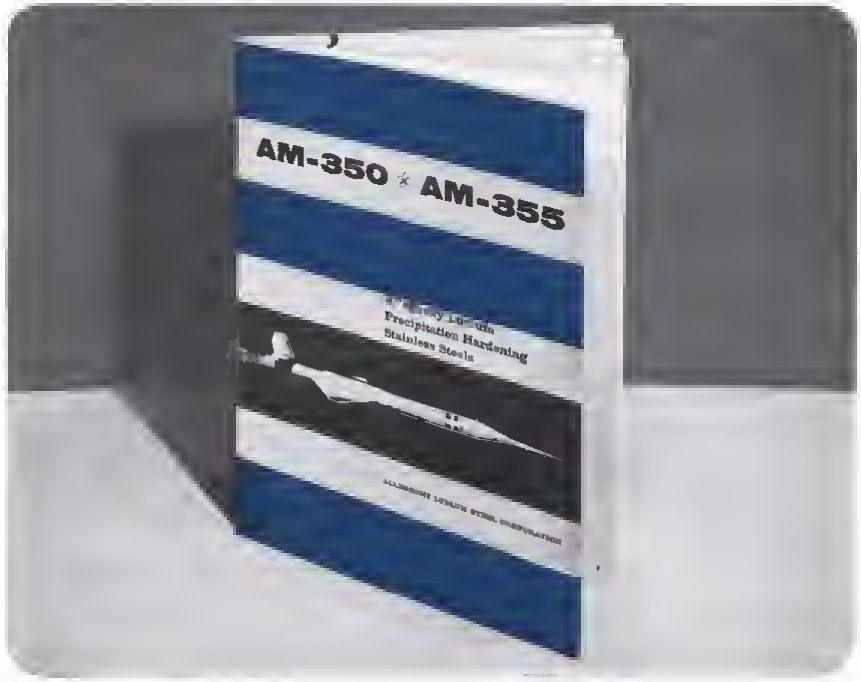

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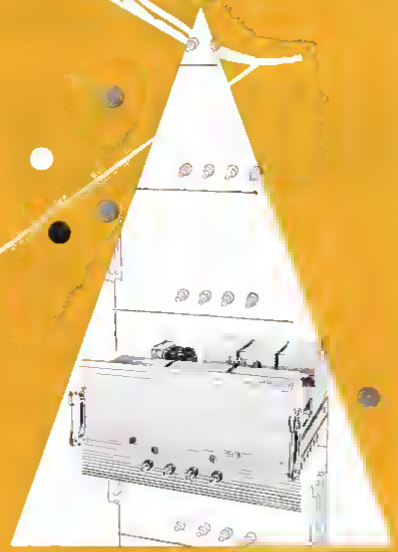

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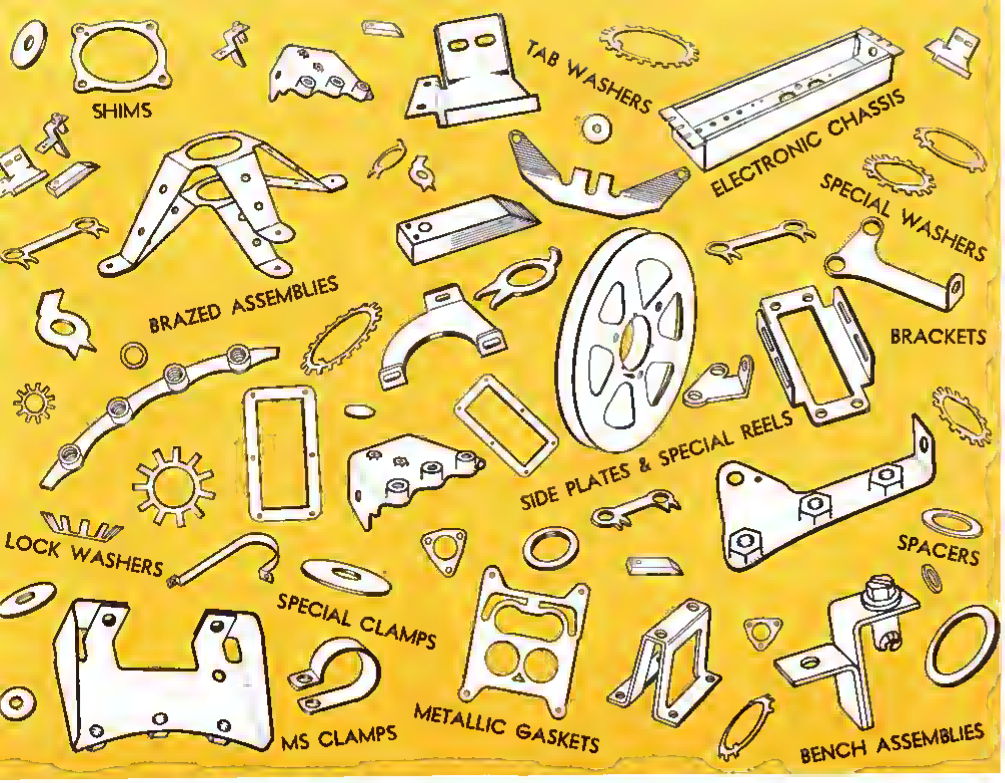

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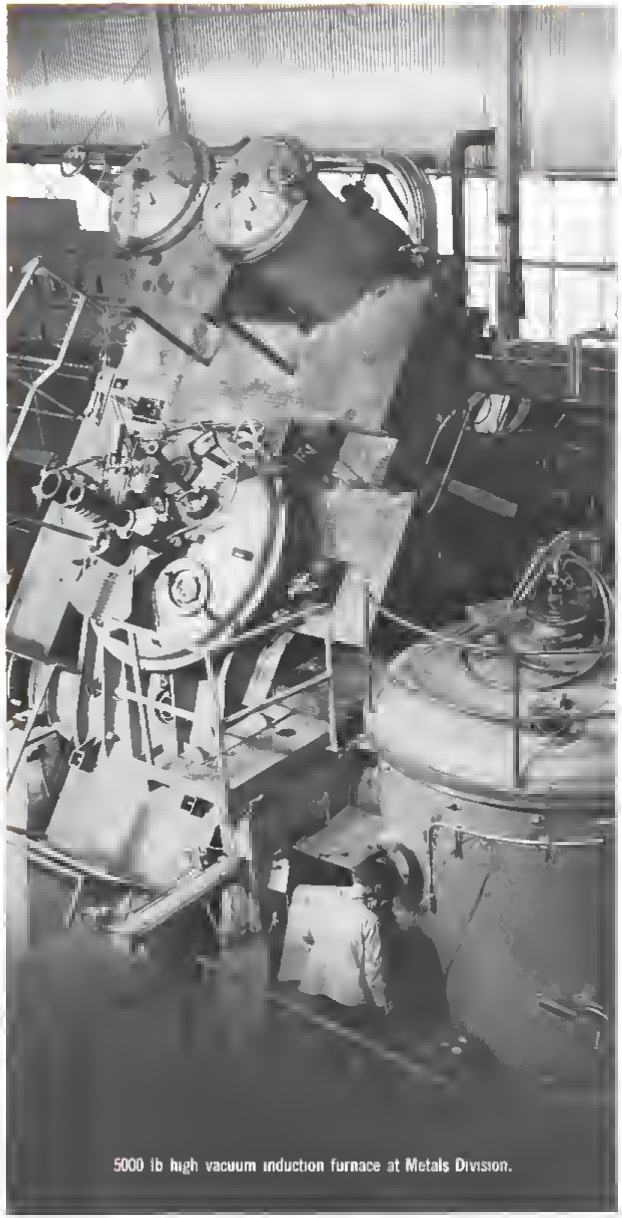

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April 4, 1960

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EDITORIAL

Changing the Mixture — 21

COVER First flight of Arma all inertial guidance system which will replace General Electric-Burroughs radio command inertial system on later squadrons of USAF-Convair Atlas intercontinental ballistic missile, makes its first flight. The Arma system rode 'piggyback' and did not control missile (AW Mar. 14, p. 35). Second test was to be a controlled flight. Arma system was described by Aviation Week May 12, 1958 (p. 92) for other photos, see p. 79.

PICTURE CREDITS

Cover—USAF 27, 56, 59, 60—NASA 49, Bell Aircraft Corp. 65, 79—USAF 70—Nord Aviation 85—Fairey Aviation Ltd. 87—Convair 88—Hughes 96, 97—Grand Central Rocket Co., 99, 103—Hiller Aircraft Corp. 91—VEB Flugzeugwerke Dresden 105—U. S. Navy 110—U. S. Army 117, 118, 119—Airborne Instruments Laboratory 121—Northrop 126, 127—Aero Club Sion, Switzerland 127—Prioleu Flugzeugwerke 129—Aviation Week 132, 133—KLM Aerocarto N.V. Luchthaven Schiphol, Hollandia 136—Cutting Industries Inc.

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EDITORIAL

Changing the Mixture

The Fiscal 1961 defense budget has not stood the test of three months of public debate very well. Public debate and legislative scrutiny have disclosed that this budget fails to meet the vital defense requirements in a number of critical areas. There are hopeful signs that the three military services, with tacit Administration approval, are already taking action to remedy the most obvious of these defects.

The number of changes that are already in the mill for the Fiscal 1961 defense budget, even before the key debates over it have begun in the Congress, must stir many questions in the minds of the taxpaying public as to the adequacy of the military budgeting process. It seems difficult to believe that a budget that was so stoutly defended as "adequate" on its presentation to Congress in January should require so many major changes only a few months later. It suggests that there is something radically wrong with the procedures and policies by which this budget was prepared.

Looking for the moment only at the Air Force aspects of the defense budget, we find an astonishing number of major deficiencies that have been spotlighted by legislative scrutiny and public debate. Among them are:

- **Lack of any modern military airlift** and little action to develop any for the foreseeable future.
- **Lack of a top priority program** to develop a Mach 3-plus replacement for the current fleet of subsonic B-52s and Mach 2 B-58s.
- **Lack of sufficient urgency** and scope for the interim Atlas and Titan ICBM programs during the critical years of the missile gap.
- **Lack of sufficient funds** and priority for developing an airborne alert capability for the B-52 fleet of Strategic Air Command in this same critical period.
- **Lack of urgency, funding and priority** for developing military space systems, both for the warning and reconnaissance satellites already under development and for advanced manned space vehicles.
- **Lack of sufficient technical effort** devoted to the increasingly important problem of monitoring and detecting nuclear explosions required for any realistic program of nuclear arms control.

USAF Reappraisal

Recent USAF action (see page 29) in reappraising its air defense program, reducing projects that have slipped too badly to be fully effective within their required time span to warrant the costs involved, and devoting smaller amounts of money to key improvements in existing components of the defensive system, is certainly a step in the right direction. It indicates an awareness, however belated, of the fundamental fact that our military picture is changing rapidly, and a more acutely sensitive response to these changes is necessary in the budgeting and programming process.

Operation Cherrytree scheduled next week at Maxwell AFB (see page 25) is another exercise badly needed to meet this problem. Apparently, Cherrytree will be the first time the top USAF command has faced realistically the cost problems of its weapon systems over their full life span from research and development through operational use in the combat inventory until replacement. It is this failure that has induced so many of the internal budget squeezes, which, compounded by the externally-imposed spending ceilings, have put so many promising technical weapon development programs on a starvation diet that has stretched out their development and production phases until they could no longer reach the combat inventory in time to provide supeniority over equivalent enemy capabilities.

This indicates that management in its broadest sense of producing maximum effectiveness at close to minimum cost rather than in its narrow sense of simply cutting costs regardless of military effectiveness, offers a tremendous area for improvement in getting more modern defense out of the funds being committed.

Sensitive Response Need

It also indicates that there is an acute need for developing a more sensitive response to the changing military and political picture and anticipating the possibilities of these changes far enough in advance to develop a technical foundation to cope with them when they arise. In this respect, it is patently ridiculous to attempt to establish any realistic system of nuclear arms control without a well developed array of technical equipment which can be used to implement and police whatever policies may come from the diplomatic conference tables.

The Air Force has at various times taken significant leads in developing and using this type equipment. The first "sniffers" that made airborne detection of the initial Soviet nuclear explosions, the radar and infrared network that detected and monitored Soviet rocket and missile tests were notable contributions as will be the Midas and Samos satellite systems. But this is an area that will require major technical support if we are to maintain our national interests in the trend toward some form of nuclear arms control that hopefully appears likely to become part of the international life of our times.

What is happening, and what should be accentuated in the Air Force's changing attitude toward its policies, problems and role in the overall policy of this nation, is typical of the effect these radically changing military and political times should have on all of our military services and their managers.

All of the services badly need more thoughtful consideration of their planning and operations that more clearly reflect the impact of the radically changing technology and politics of our times rather than blindly pursuing their traditional courses down a road narrowed further by arbitrary budget ceilings that bear no particular relation to anything.

—Robert Hotz

WHO'S WHERE

In the Front Office

George S. Trimble, Jr., corporate vice president for advanced programs, The Martin Co., Baltimore, Md. Also **Richard F. Wehrlin**, director general for international operations with temporary headquarters in Wiesbaden, Germany.

Gerald E. Donovan, president, Data Graphic Systems, Inc., Santa Monica, Calif., succeeding **Matthew M. Gunger**. Mr. Donovan continues as vice president-finance of Douglas Aircraft Co., Inc. Other Data Graphic appointments: **Francis A. Niveos**, vice president and general manager, **Russell S. Ellsworth**, vice president sales and service.

Raytheon Co., Waltham, Mass., has elected the following as vice presidents: **T. C. Wisenbaker**, general manager, Missile Systems Division; **Paul F. Hannah**, general counsel and secretary; **George Ingram, Jr.**, controller.

S. E. Damyow, vice president rocket and ballistic operations, Rocket Power Talco Division of The Gabriel Co., Mesa, Ariz.

Allied Research Associates, Inc., Boston, Mass., has established two technical divisions and made the following appointments: **Daniel J. Fink**, vice president, Research Division; **Roger S. Warner, Jr.**, vice president, Engineering Division. Also: **Dr. Arthur Winston**, chief scientist, Research Division; **Claude Brenner**, chief engineer, Engineering.

Sven H. Dodington, technical director, government projects, International Telephone & Telegraph Corporation Laboratories, Nutley, N. J.

Norman J. Golden, vice president, research and development, Semiconductor Division of Hoffman Electronics Corp., Los Angeles.

Edward J. Horkey, vice president, engineering, Houston Fearless Corp., Los Angeles, Calif. Mr. Horkey continues as president and chief executive officer of Horkey-Moore Associates, a Houston Fearless subsidiary.

Henry Morgan, president and general manager, Electronic Controls, Inc., Stamford, Conn.

Robert O. Vaughan, vice president, marketing, Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc., Houston, Tex.

John K. Hilliard, vice president and director of the newly formed Ling-Altec Research Division of Ling-Altec Electronics, Inc., Anaheim, Calif. Also: **Dr. Walter T. Fiala**, chief physicist.

Honors and Elections

David R. Hull, a vice president of Raytheon Co., has been named recipient of the 1960 Electronic Industries Assn.'s medal of honor for "distinguished service contributing to the advancement of the electronics industry."

Harry Passmore, III, a Convair aerophysics engineer, has been selected as the Institute of the Aeronautical Sciences Flight Test Engineering Fellow for 1960.

Ralph P. Alex, assistant chief of component design for Sikorsky Aircraft, has been re-elected president of the International Helicopter Commission of the Federation Aeronautique Internationale.

(Continued on page 141)

INDUSTRY OBSERVER

► Smaller version of the Minuteman, designated Midgetman, with reduced payload and range for use as a solid propellant IRBM, may be proposed for NATO use.

► Navy has under way an advanced program designed to develop movable nozzles for Polaris missile engines. Air Force's Minuteman will have movable nozzles, and Navy's Subroc underwater-to-air-to-underwater anti-submarine missile also may use this method of vector control.

► Feasibility of fabricating rocket engine nozzles from ablative materials at one-tenth or less the cost of present nozzles has been established by Air Force-sponsored research. The ablative-type nozzle would deteriorate at a slow enough rate to remain operable until burnout occurs. Present nozzle designs are very costly to produce because of the extremely fine tolerances required.

► Air Force Boeing KC-135 tanker is being modified for use in weightlessness research programs now being conducted by USAF's Aerospace Medical Laboratory at Wright-Patterson AFB, Ohio, with a Convair C-131. KC-135 is expected to provide weightless periods of 30 sec. at a time and will be compartmented so that a number of experiments can be carried out at the same time. USAF's School of Aviation Medicine and National Aeronautics and Space Administration are expected to participate in the experiments. Aircraft is due to be ready for shakedown flights in about one month. C-131 also will continue to be used.

► Canadian treasury has approved a $16.5 million purchase order for four Lockheed C-130B Hercules turboprop transports for use by Royal Canadian Air Force. Negotiations between USAF and the Canadian government to expedite delivery dates are now under way. Purchase was made possible by a budgetary surplus resulting from cancellation of the Avro CF-105 re-equipment program. Lockheed is expected to use the Canadian order as a sales argument in marketing the C-130B to U.S. commercial carriers, three of which have ordered the Canadian-built Canadair CL-44 freighter.

► Small solid rockets being considered for use around the base of the Saturn booster would be employed as part of a booster recovery system.

► Navy has designated the Pratt & Whitney JTF10A-1 turbofan engine the TF-30. Navy will use the 8,250 lb. thrust engine as the powerplant for its subsonic Missileer aircraft to be used as a launching platform for the Navy-Bendix-Grumman Eagle air-to-air missile (AW Mar. 21, p. 23). Navy decision for a Missileer airframe is expected before May 1.

► First two firings of Air Force's 609A missile, military version of National Aeronautics and Space Administration's Scout, will be from Pad 18A, the former Vanguard launching site at Cape Canaveral, Fla. Next two will be from Pad 18B, a Thor launch site, while 18A is being modified for more complex versions of the missile. NASA plans do not now include any Scout launchings from Cape Canaveral; all are presently scheduled from the agency's Wallops Station, Va., launch site (see p. 56).

► NASA's seven Mercury pilots will get two Convair F-106 interceptors for use in proficiency flying as soon as USAF's air defense unit at Langley AFB, Va., is outfitted with them. Mercury pilots are now using Lockheed T-33s and Convair F-102s (AW Oct. 19, p. 23).

► Study of general criteria for Minuteman solid-propellant base and facility design will be submitted to the Air Force in June by Roberts and Schaefer, Chicago and New York architectural and engineering firm.

► Air Force has decided not to construct a hardened combat operations center near Colorado Springs, Colo., for the North American Air Defense Command at least for the present following a recent revision in USAF's air defense program which canceled plans for construction of eight underground SAGE super-combat centers.

Washington Roundup

Coolidge Report Conclusions

White House has pigeon-holed a report that says the U. S. has tacitly accepted a position as a second class world power during the past decade and has reduced its military power to such a bare minimum that further disarmament would dangerously weaken its power to negotiate with the Soviet Union. These are the conclusions of the Coolidge Commission arms control study completed several months ago for President Eisenhower.

Coolidge Report paints a darker picture than the celebrated Gaither Report, and it probably will become an election-year storm center. Congress will fight to have the Coolidge study published, but it seems destined to remain under the cloak of executive privilege along with the still-unpublished Gaither Report.

White House maintains the arms control study is an internal working paper never intended for publication or legislative use. It has resisted attempts by the Senate Preparedness Subcommittee headed by Lyndon Johnson and Senate Disarmament Subcommittee headed by Hubert Humphrey to gain access to the report, although parts of the study are being used in the current nuclear arms control conference in Geneva.

Power Deterioration

Report says the deterioration of U. S. military power in relation to the USSR has turned the tide of leadership in Asia against the U. S. and in favor of the Soviet Union. This shift is traced to an Asian belief that the U. S. lacks sufficient military power to defend its friends there. Similar weakening of ties with European allies was cited for the same reason.

Study emphasizes that the worst U. S. deficiency lies in conventional arms. While the Soviet Union has modernized its non-nuclear forces twice since World War II, the Coolidge group notes U. S. conventional forces still rely basically on 1940-45-vintage equipment.

High cost of arms control systems was the conclusion most distasteful to the Administration. The report found that arms control equipment, manpower and enforcement activities would cost almost as much as the current military budget.

Coolidge Commission recommends a new organization to supply the coordination of basic arms control policy now lacking. Report found no organizational means of coordinating policy between the Pentagon, State Department, Budget Bureau and other agencies. Permanent technical, professional staff organization is recommended for a continuing study of arms control methods and policies in relation to basic U. S. strategy.

USAF Weapons Evaluation

Top Air Force commanders will take a hard look at weapon system development and production programs for the next decade during Cherrytree, a three-day session beginning Apr. 15 at Maxwell AFB, Ala. Purpose is to develop a realistic budget evaluation of the complete spectrum of USAF weapon systems from the research and development phase to the end of operational life. After two days of briefing, the group will decide what programs will form the hard core of the Air Force weapon structure over the next ten years.

Government program to develop a supersonic transport for sale to U. S. airlines is under serious consideration in the White House. These aircraft would have military use, but the basic aim of the program would be to beat the Russians into passenger service with a supersonic transport.

Supersonic transport program begun now would help the U. S. avoid the inevitable crash effort that would develop later if the Soviet Union produces a transport in this class. Soviet design group under Andrei Tupolev is generally believed to have been working on a Mach 2 transport for two years.

Defense Department is trying to put sharp legal teeth into a proposed directive that will establish rigid censorship by Assistant Defense Secretary Murray Snyder's office over all contractor advertising. New directive goes beyond the usual security review concept to include advertising policy control. It would censor references to such matters as the economic implications of contracts and the relationship of specific weapons to military policies.

New regulations will hit educational institutions and nonprofit organizations as well as industrial contractors.

MATS Modernization

Air Force will ask Congress for an additional $236 million in the Fiscal 1961 budget to modernize the MATS transport fleet. Most of this extra money will be earmarked for quick purchase of Boeing KC-135s with minimum modification to switch them from tankers to cargo transports. Balance will be spent to develop a new design for a basic workhorse cargo transport. This new design will be turbofan-powered and will be the principal replacement for the current MATS fleet.

—Washington Staff

Major Role Planned for Snap-Type Units

Nuclear-electric systems foreseen as predominant propulsion, secondary power source in 1965-70 era.

By Evert Clark

Washington—Nuclear electric power systems, typified by the National Aeronautics and Space Administration's Snap 8 (AW Mar 28, p 31), are expected to become the predominant and most reliable sources of propulsive and secondary power for satellites and space probes in the 1965-1970 period.

As short a time as two years ago, availability of these systems was believed to be much further away in time. Success of the Atomic Energy Commission-industry small reactor program and tests of small conversion systems are now making it possible to begin the scaling of experimental components into useful systems.

First of these will be the 30 kilowatt Snap 8 and the 300 watt Snap 10 (AW Feb. 29, p. 26), but Air Force's Air Research and Development Command expects to award a feasibility study within the near future for a 300-kilowatt system, and needs for units producing as high as 1 000 kw are foreseen.

Snap 8 will use a reactor being developed by Atomics International Division of North American Aviation, Inc., which is a scale-up of the 50 kw zirconium hydride-moderated Snap 2 reactor. It will use a liquid mercury-turbine electrical generator system to be developed by Aerojet-General.

First propulsion unit to be used with Snap 8 will be an ion engine having ⅛ to 1 lb of thrust. NASA is expected to open competitions soon for ⅛ lb and ½ lb thrust ion engines. Later, an arc-plasma jet propulsion unit will be used.

Snap 8 eventually will exist in the 30 kw version and a 60 kw version. The larger system will still use the same reactor but will have two energy conversion systems.

Aerojet Contract

Aerojet's $8 million contract will call for one conversion system with a 90 day reliable lifetime to be delivered within 3½ years and another with a 1-year reliability to be delivered within 5 years. Aerojet will be responsible for the entire 650-lb conversion system. It will consist of a loop in which liquid metal such as potassium or rubidium is heated by the 250-lb reactor and passed through a boiler, another loop, probably containing mercury, which will be passed through the boiler, a turbine turned by the vaporized liquid mercury to power an electrical generator, and a radiator system for cooling the mercury. Since efficiency of the system is only 20-25%, some 75-80% of the heat must be dissipated into space. Although the radiator system, which will need to be several hundred square feet in area, is believed by some to be the most difficult part to successfully develop, NASA hopes to have a complete system ready for flight tests within three and one-half years.

The 30 kw Snap 8 system, including shielding, will weigh about 1,500 lb. Robert E. English of NASA's Lewis Propulsion Laboratory told the Joint Congressional Committee on Atomic Energy that Snap 8 could be used with the Agena, Centaur and Saturn vehicles. A 60 kw version weighing 3 000 lb could power a 15-ton spacecraft and also provide its secondary power. The 30-kw version "will be suitable with the Agena-launched space vehicles and the 60-kw version with Centaur-launched vehicles," English maintained.

J. R. Wetch, chief project engineer for Atomics International's Snap reactor program, told the committee that a small mercury vapor turbine generator has been operating for more than 1,000 hr. in AEC's Snap program with no deterioration of performance. He likened this to 50,000 mi. of nonstop operation of an automobile.

Completed Phases

Wetch pointed out that Snap 2, part of the general Systems for Nuclear Auxiliary Power Program laid down in 1955, has just completed its research and feasibility phase.

The larger effort of developing this hardware for the space environment and integrating the power conversion machinery with the nuclear heat source and finally the satellite vehicle, is only now commencing," Wetch said.

These forthcoming integration tests, automatic control tests, vibration and shock tests and remote orbital start up demonstrations will require a great deal of attention over the next two to three years.

"Upon completion of these engineering development activities, a reliability and endurance qualification demonstration phase will be required before these power units would be operationally coupled with satellite vehicles which are valued in the millions and tens of millions of dollars.

"Thus, nearly a decade will have passed since research and feasibility efforts were originally funded for development of a satellite nuclear APU (Auxiliary Power Unit), and the time that the nuclear APU will be ready for operational use."

This kind of time scale and the fact that reliability demands will require life testing of some units means that we must undertake our first steps of determined research to establish design criteria immediately if we do not wish to seriously delay our total space capability," Wetch said.

English said the 60-kw Snap 8, launched into a 300 mi. orbit aboard a 9,000 lb satellite by means of the Centaur vehicle, could use an electric rocket to propel the satellite into higher and higher orbits about the earth. By propelling for about 40 days, the electrical system could raise a payload of 3,000 lb into the so-called "stationary" 24-hr. orbit, 22,300 mi. above the earth.

Since the thrust of electrical rocket engines is so small, more time is required to put a satellite or probe into position than with a chemical rocket. But the Snap systems have the value of doing dual service—propulsion plus providing the electrical power needed for operation of instruments after the payload is delivered.

A Mars probe of 500 lb. could be delivered by a chemical rocket system in 250 days, English said. Snap 8 could lift a comparable system in the same period. But if the time were increased to 350 days, Snap's payload could be 3,000 lb. in addition to its own 3,000 lb. 60-kw power system, English maintained.

Increasing Electrical Needs

Wetch said the need for large secondary power systems aside from the question of propulsion, is illustrated by the increasing electrical needs of aircraft weapon systems. The North American F-108 was to have required about 100 kw. for a crew of two and the B-70 up to 360 kw. for a crew of four. One thousand kilowatts would be sufficient to provide pressurization, air purification communications power and experimental laboratory power, etc. for a 10 to 20 man space station on high altitude earth orbits, Wetch said.

Other Possibilities

Wetch also foresaw the following non-military possibilities for Snap systems:

- Several global communications systems in the 1965-1970 period using Centaur and Saturn launchers. These would include multichannel all-weather TM radio coverage of all parts of the world, regardless of degree of local economic and broadcasting facilities development."
- "It appears that the Snap 8 system could provide sufficient power for a channel of continuous television broadcasting on a complete global basis that could be received by the conventional television sets which are now commonly in use."
- "The family of Snap units in this decade can provide sufficient electric power for near earth satellites to accomplish precise air traffic control and navigational aid functions."
- "Satellite global weather surveying and mapping can be much more detailed reliable and accurate when using the higher powers provided by Snap units."

Similar Advanced Materials

Although the turbine-generator Snap 8 and the thermoelectric direct conversion Snap 10 use the same advanced materials, physics and control techniques developed in Snap 2 and operate in the same 1,200 to 1,300F temperature range, high temperatures and corrosion are problems which still need considerable research.

Robert H. Fox, assistant division leader for reactor research and advanced concepts in the Lawrence Radiation Laboratory's Nuclear Propulsion Division, told the committee that the 2,000F reactor temperatures and 1,000F radiator temperatures plus the associated chemical corrosion require "a long range basic research activity in corrosion at high temperatures."

Mars Vehicle Needs

A two or three man Mars vehicle probably would require some 30,000 lb. for the passengers' supplies and equipment, some 50,000 lb. of liquid cesium fuel and a vehicle gross weight of 100,000 lb. Fox said. Power consumption of a 15 lb.-thrust electric rocket would be some 1,000 kw. Such a vehicle may require 15 to 20 years and possibly as high as 30 years to develop.

Jet Relationship

Right now we are about in the same position as we were with respect to jet engines in the late 1930s," Fox said.

Nuclear-electric and other satellite power systems are generating interest among a wide variety of companies (see box on p. 26). Final bidders in the Snap 8 competition won by Aerojet were AiResearch Division of the Garrett Corp., Thompson Ramo Wooldridge's Tapco Group, Pratt & Whitney Division of United Aircraft Corp., Allison Division of General Motors, General Electric Co., Walter Kidde & Co. Inc. and Allis-Chalmers.

Sunflower Competition

Washington—Unusual mixture of 23 engine airframe, electronic and component manufacturing companies have entered the National Aeronautics and Space Administration competition to develop a three-kilowatt Sunflower I solar collector power system for use with satellites launched by the Centaur and Saturn space vehicles (AW Feb. 29, p. 26).

Award of a contract is due early this month. Bidders who entered proposals on Mar. 17 were:

Convair, Raytheon, Allison Division of General Motors, Cook Research Laboratories, Thompson Products, North American Aviation's Missile Division, Sundstrand, General Electric's Missile Division, the Pratt & Whitney and Hamilton Standard Divisions of United Aircraft Corp., Boeing, Avco, Marquardt, Westinghouse, RCA's Astro-Electronic Products Division, Armour Research Foundation, AiResearch Division of Garrett, Solar Aircraft Co., Martin Co., Lockheed's Missile Division, Texas Instruments, Hoffman Laboratories and International Telephone & Telegraph Laboratories.

Close Shaves for Saturn

Washington—Two attempts were made to kill the Saturn 1.5 million lb. space booster project and two requests for top priority were turned down before the project was transferred to National Aeronautics and Space Administration Roy W. Johnson, former director of Defense Department's Advanced Research Projects Agency, told the House Committee on Science and Astronautics last week.

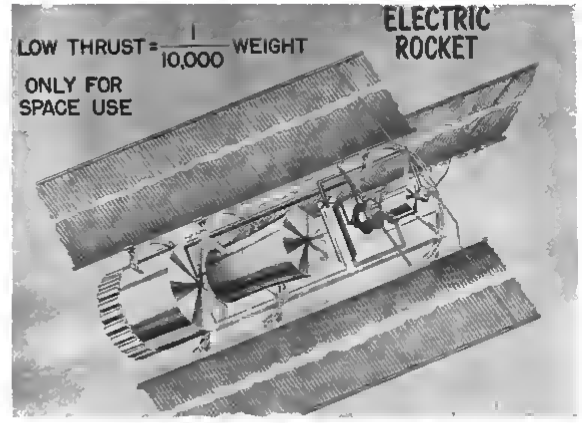
Johnson also said "the budget has become the chief management tool within the Pentagon."

Johnson said that late last summer Dr. Herbert York, Defense director of research and engineering, told him that he had decided to cancel the Saturn program because "there is no military justification therefor . . . any military requirement can be accommodated by the Titan-C as proposed by the Air Force . . . by the cancellation the department will be in a position to terminate the costly operation being conducted at Army Ballistic Missile Agency."

Johnson said he then proposed transferring Saturn to NASA. A review of plans for Titan-C, Saturn and the Nova booster followed in September, and York "finally agreed" to continuation of Saturn and began negotiations for its transfer to NASA, Johnson said.

Another attempt had been made in November, 1958, chiefly by the Budget Bureau, to kill the project. ARPA at that time opposed a transfer to NASA, and NASA Administrator T. Keith Glennan did not urge the transfer, Johnson said.

Attempts on Dec. 9, 1958 and May 22, 1959, to gain the top-rated DX priority for Saturn failed. It finally received this priority recently, after its transfer to NASA was announced.



SNAP 8 nuclear-electric propulsion and auxiliary power system being developed by NASA uses reactor, liquid metal loops, boiler, turbine-generator and large radiator. Electrical system will power a small ion engine for which competition is due soon.

Nuclear-Powered Engines Urged For Space Vehicle Upper Stages

Washington—Use of heat-exchanger nuclear engines to propel space vehicles seems to be a matter of detailed engineering, money and a determination to carry through such a project, according to Dr Ramon E Schreiber, technical director of Atomic Energy Commission's Project Rover nuclear reactor project

Schreiber, testifying before the Research and Development Subcommittee of the Joint Congressional Committee on Atomic Energy, indicated that most of the "limited effort" authorized for the Rover program has been expended on the Kiwi A test reactor and that experiments with it had convinced AEC scientists working on the project at the Los Alamos Scientific Laboratory that there is little doubt of the feasibility of high power density heat exchanger reactors suitable for large nuclear rocket engines Performance of the nuclear rocket which could be built if development began today also was estimated by Schreiber He said

"It seems generally possible to achieve about twice the specific impulse of the best chemical systems by means of the nuclear propulsion technology now available"

Schreiber added that on this basis one nuclear stage could do the work of two oxygen-hydrogen chemical stages, except that the nuclear engines had a slightly greater dead weight and this would cut the performance differential to a small degree On large vehicles, Schreiber said that the substitution of one nuclear upper stage for one or two chemical stages almost invariably increased the payload by 60-to-100%

In his progress report to the committee on Project Orion, the U S bomb powered rocket program, Dr Stanislaus Ulam of Los Alamos said

'Detailed plans for construction of a ship (with payloads upward of 1,000 tons) and some experiments on such means of propulsion have already been made by General Atomic (Division of General Dynamics Corp) In Los Alamos some experiments relevant to nuclear propulsion in this fashion have been started"

Ulam indicated that the program to develop such a vehicle would be a large one, but he suggested that studies of it be continued and that "some mock up experiments using ordinary chemical explosions to imitate the action of repeated impulses to study the ablation of the exposed surface, etc" should be funded

Rear section of such a rocket would be indented in the shape of a hemisphere and coated with a thick layer of solid ablating material Explosion of the small atomic bomb expelled out of the rear of the rocket would not only impart a high pressure impulse to the rocket but its heat would melt away a layer of the ablating material and force it along the bottom, finally expelling it at high velocity in the opposite direction to the rocket's motion

Specific impulse and efficiency of the bomb-powered rocket is materially increased by use of the ablating material Sharp pressure impulses from the bomb explosions are not expected to impose accelerations of more than 2 or 3g on the vehicle and will last for only a few minutes Internal spring arrangements probably will be used to damp the accelerations reaching the crew and sensitive equipment

During the next few months the Los Alamos group plans to test a new reactor Kiwi-A Prime, "to evaluate detailed design features evolving from the Kiwi-A experience," Schreiber said This reactor will be tested until there is 'positive evidence of damage to the reactor" to get the necessary failure data Current work at Los Alamos includes a new generation of Kiwi reactors which will be united to a liquid hydrogen supply system a liquid hydrogen regeneratively cooled nozzle and a simplified control system This type of effort is needed to turn the present reactors into a rocket engine

Schreiber discussed two methods of several being considered for actual flight testing of a nuclear rocket One was a 'lob' shot in which the test vehicle would have its total impulse restricted to limit range The other was the placing of an experimental engine into orbit with chemical boosters and to conduct the tests remotely above the atmosphere

Another phase of the Rover work which will be pursued more energetically in the future is the investigation of problems connected with building very large nuclear rockets and extrapolating the data that has been obtained thus far on Kiwi-A and will be obtained shortly on other heat exchanger reactors Testimony has indicated that the first nuclear rockets will have about 100,000 lb thrust with a 2,000 megawatt reactor

Schreiber told the congressional committee that testing of large engines in this phase of the program would require new facilities and a general expansion

Ultimate potential of nuclear power systems probably will be reached with liquid or gaseous fuel rather than solid fuel reactors, according to Schreiber Reactors of this type might be developed by pooling the knowledge of the Sherwood (controlled fusion) program and the Rover program, and Schreiber said this is being done and that plasma reactor schemes are being studied Theoretical efficiencies of these reactors are many times higher than those of the current heat exchanger reactors

More complete rundown on the immediate potential of nuclear rockets was given last week by Air Force Lt Col Howard R Schmidt, chief of the Nuclear Rocket Section of AEC's Division of Reactor Development, at the American Power Conference in Chicago

Schmidt said a three stage Saturn vehicle using two nuclear engines with the chemical first stage would provide a payload capability four times higher than the five stage chemical configuration which is about the payload of the four stage Nova First stage of the Nova under current plans will have four of the 1 5 million lb thrust single barrel engines now under development by Rocketdyne Division of North American Aviation Inc

Col Schmidt believes that a chemical-nuclear Saturn could be operational within 15 years He presented figures to show that $24 million in vehicle costs per mission probably could be saved by replacing the Nova with the chemical nuclear Saturn This estimate, he said, was obtained at in two ways

One was on the basis of an average cost of $150 per pound of dry weight for any large vehicle purchased in groups of 100 Using this yard stick, the all chemical Saturn and the Nova will cost $14 million and $48 million respectively The chemical-nuclear Saturn would cost $24 million, including the estimated cost of $10 million for two reactors

Rocket Study Competition

Washington—Proposals are due on Apr 11 in an Air Force nuclear rocket study requirement competition following a bidder's conference held at Edwards AFB, Calif on Mar 15. Decision probably will result in partially funded study contracts to two industry companies No specific vehicle application has yet been pinpointed for the projected nuclear rocket

Industry members attending the conference included North American Aviation s Rocketdyne Division, Aerojet-General, Pratt & Whitney Aircraft, McDonnell, Northrop, Marquardt Corp, Curtiss-Wright, Republic General Electric Westinghouse, Douglas Bell Aircraft Lockheed, Martin, Boeing, Thiokol and Allison Division of General Motors Corp

USAF Plans Shift in Air Defense Pattern

By Philip J. Klass

Washington—Air Force is proposing a sharp cutback in the Boeing Bomarc-B and SAGE super combat center programs in order to provide almost $400 million for increased procurement of Atlas intercontinental ballistic missiles and to expedite operational dates of the Minuteman missile, Midas and Samos satellites and the Ballistic Missile Early Warning System

As outlined to the House Appropriations Committee, the major revision in the Fiscal 1961 budget request which Air Force submitted in late January reflects growing recognition that the dominant Soviet threat comes from its growing numbers of ballistic missiles despite the fact the Soviets still possess a formidable bomber fleet

Air Force proposes to produce the Bomarc-B interceptor missiles now under contract but to order no more This action is expected to save $381 1 million of the $421.5 million USAF originally requested for the program in Fiscal 1961 In subsequent years, the cutback is expected to save an additional $451 3 million that would have been needed to complete the originally planned numbers of Bomarc-B missiles and to build their launching sites Total savings is estimated at $854 4 million Bomarc B sites already completed in the northeastern portion of the U S would be outfitted with the missiles but construction would be halted at other sites

The Air Force action is expected to strengthen the hands of congressional critics of the Bomarc who may seek to have the program canceled completely without completing the missiles now under contract An Air Force spokesman estimated that something less than $250 million could be salvaged if the entire Bomarc program were canceled

Air Force decision not to proceed with construction of eight hardened SAGE super-combat centers, each equipped with larger capacity, transistorized version of the present SAGE AN/FSQ 7 computers, slashes $132 4 million from the original Fiscal 1961 budget request and is expected to save another $141 8 million in Fiscal 1960 funds Another estimated $124 7 million would have been needed to complete the program so that a net saving of $398 9 million over several years is anticipated Air Force will complete the existing SAGE system consisting of 20 sector direction centers and three combat centers

In testimony before the House Appropriations Committee, Gen Thomas D White, Air Force chief of staff, left little doubt that the decisions to cut back on Bomarc and SAGE were difficult ones to make "We are trying here," Gen White said, 'within the President's budget, to shift our emphasis to give us a good air defense rather than we would have had it and to put some of the moneys on systems which will better meet the future as we see it While I recognize the threat of the air-breathing bomber exists as of today as the most important, most deadly threat against this nation, it is quite obvious that the intercontinental ballistic missile is to become the predominant threat to this nation of the two systems, the ICBM will, in my opinion, become the dominant one"

Gen White admitted that Gen Lawrence Kuter, commander of the North American Air Defense Command, does not agree with the latest proposed program Gen Kuter would like to continue the Bomarc B program, build the SAGE super-combat centers, reinstate the North American F-108 Mach 3 interceptor and believes that Army s Nike Zeus anti ICBM missile system should be put in production, Gen White said

Revised Program

The revised Air Force program does have the approval of the Joint Chiefs of Staff and the Secretary of the Air Force, Gen White testified He added that in the absence of Secretary of Defense Thomas S Gates, Jr, the Defense Department has approved the cutbacks and authorized the Air Force to present its proposal to the House but has not yet given official concurrence for those items which USAF proposes to buy with the funds saved by the cutbacks

In response to House committee questioning Gen White disclosed that the Air Force would like to spend all of the $516 million cutback savings, plus another $26 7 million for additional items, including Lockheed C-130B cargo planes, rocket engine development and Military Air Transport Service modernization but had been overruled on this by Defense Department officials The reason, according to Gen White, was that there is an $18 6 billion limitation on Air Force Fiscal 1961 expenditures and the additional items would have pushed USAF over this figure

Air Force received Defense Department approval to propose alternative programs totaling $123 7 million less than it had earlier requested in its Fiscal 1961 budget

Air Force decision to radically alter its request for Bomarc-B funding following last year's budget hassle between its interceptor missile and the Army's Nike Hercules area defense missile may have been prompted by concern that Bomarc-B had become an extremely vulnerable program for congressional critics because of delays and technical difficulties in the program even though the latter were not considered serious by those familiar with the project

Army supporters in Congress, critical of the Administration decision to hold back production of the Nike Zeus, were expected to level their fire at the high level of Bomarc funding in the face of the rising ballistic missile threat The Air Force ran the risk of criticism for being preoccupied with the 'wrong threat" if it continued to pour close to a billion dollars a year into Bomarc-B and SAGE (AW Feb 8, p 32) Also against manned bombers flying at extremely low altitudes the Bomarc guidance system reportedly was not as effective as at high altitudes

The decision to abandon the SAGE super combat centers was somewhat easier The expense of hardened, underground SAGE installations for air

Air Defense Reorientation Summary

(Millions of dollars)

	Fiscal Year 1960 New Obligational Authority			Fiscal Year 1961 New Obligational Authority		
	Present Program	Revised Program	Difference	Present Program	Revised Program	Difference
Aircraft procurement	89 2	89 2		81 9	218 1	136 2
Missile procurement	1,338 4	1,338 4		1,824 7	1,548 7	−276 0
Military construction	517 9	557 9	40 0	166 8	146 1	20 7
Research, development, test, and evaluation	351 1	376 7	25 6	296 4	407 2	110 8
Other procurement	510 4	429 8	−80 6	423 4	351 4	−72 0
Total	2,807 0	2,792 0	−15 0	2,793 2	2,669 5	−123 7

Interceptor Proposals

Washington—Air Force studies of possible replacements for the North American F 108 Mach 3 interceptor reportedly include a North American proposal to build a slower Mach 2 version using aluminum rather than the originally planned stainless steel and perhaps incorporating an ablative covering that would be sprayed on after each mission. Other contenders include the Navy/North American A3J, the USAF/Convair B 58C and the Navy/McDonnell F4H. Difficulty of squeezing the large long range radar and fire control system into the F4H may drop the Navy interceptor from the list of contenders.

defense is of questionable value unless the radars which supply target information the interconnecting communications, the interceptor airfields and Bomarc sites are equally hardened.

Air Force testimony before the House committee disclosed that it would have been at least 1964 before the super combat centers were operational and the date probably would have slipped into 1965 or 1966.

A portion of the funds salvaged from the Bomarc B and SACE cutbacks will be used to strengthen existing air defenses against manned bombers. This program includes:

• **Interceptor improvement.** Air Force proposes to modernize existing McDonnell F-101B and Convair F-102 and F-106 aircraft to bring them abreast of latest factory designs. Improvements will include addition of new time-division multiplex data link equipment, which enables SAGE computers to automatically fly interceptors to the vicinity of their targets. Interceptor radar will be modified to make it more resistant to enemy electronic countermeasures. Interceptors also will be outfitted to carry new GAR-11 nuclear-tipped air-to-air missile developed by Hughes Aircraft Co. Whereas the MB-1 (Genie) is an unguided nuclear-tipped rocket, whose warhead must be set before launch for the explosion time, the GAR-11 will home automatically on its target and presumably detonate automatically at the correct distance from target, greatly increasing its kill probability over the MB-1. Air Force seeks a total of $232.6 million in Fiscal 1961, an increase of $135.7 million over its original request.

• **New interceptor missile, radar.** Extremely long-range pulse doppler radar (AN/ASG-18) and GAR-9 long-range air-to-air missile, both developed by Hughes and originally slated for the F-108, would be continued in development on a modest funding basis under Air Force's proposed program. The extremely long range of the interceptor radar and the air-launched missile, which travels at hypersonic speed, would enable an interceptor to seek out its target using only meager ground-controlled intercept radar information. This would permit an interceptor to operate from DEW Line surveillance radars or in areas where SACE computers might be knocked out. The Hughes program, which was scheduled to be canceled when the F-108 was terminated, would be funded with $15 million next year under the proposal.

• **Improved surveillance radar.** Air Force proposes to modernize existing ground-air defense radars with a $13 million increase in current funding and a $15.4 million increase in Fiscal 1961, bringing that year's total to $145.7 million. Modernization will include addition of frequency-diversity, the use of multiple frequencies which extends detection range and reduces vulnerability to electronic countermeasures.

Air Force proposes modest increases in these programs:

• **Midas, Samos.** Air Force proposes an additional $25.6 million for its Lockheed satellite program in Fiscal 1960, bringing its total to $324.5 million for the year. In Fiscal 1961, it seeks an additional $35.8 million for a total of $368.8 million. Additional funds include provisions for increased firings of the Discoverer series satellites, test vehicles for the Midas and Samos, with the bulk of the current year increase specifically earmarked for Midas.

• **Minuteman.** An additional $27 million is proposed in Fiscal 1961 for a total of $476.1 million, with additional funds used to increase research and development effort and expand production facilities.

• **BMEWS.** Air Force is asking for an additional $14.9 million in current year funding, bringing the total to $272.0 million with a requested $27.6 million increase in Fiscal 1961 for a 1961 total of $134.9 million to accelerate the initial operational date of the Alaskan site by several months and the British site by perhaps a year. Until the latter site is operational, portions of the U.S. will be exposed to Soviet ICBM attack without prior detection by radars in Greenland or Alaska.

Air Force proposes to increase the number of Atlas missiles per squadron from 9 to 12 at six existing sites rather than construct additional Atlas missile bases. The $90 million increase in Fiscal 1960 funds requested would be used for construction of additional launching facilities. The $136 million increase sought for Fiscal 1961 would be spent for the additional missiles and ground support equipment.

Boeing now has approximately 10,500 employes directly engaged in Bomarc-B production, with approximately another 5,000 in related and supervisory positions. The total represents about 20% of the company's work force.

If the Air Force plan is approved, Boeing is expected to drop approximately 5,000 employes during the current year, with the figure reaching 15,000 over the next two years. If the entire program were to be terminated, the layoffs would be immediate. The Bomarc program last year represented about 15% of the company's total sales.

Westinghouse Electric's Air Arm Division, which produces the radar controlled guidance system used in the Bomarc, also is expected to feel the effects of the program changes.

As originally programed, the Bomarc program, including A and B models, was expected to cost a total of $3.1 billion. The revised program proposed by the Air Force would cut its cost to $2.2 billion. If the program were terminated completely, the total program cost would be under $2 billion.

Another cutback, not specifically mentioned in Air Force testimony, is the Airborne Long Range Intercept (ALRI) program recently awarded to Burroughs Corp. The program which originally called for outfitting 80 RC-121 aircraft with improved radar and data processing equipment to extend range of SACE, has been cut back to 30 aircraft.

The Air Force's proposed Bomarc-B cutback did not come as a surprise to Canadian defense officials who earlier made the difficult and controversial decision to cancel Canada's work on its CF-105 interceptor in favor of the Bomarc-B. Defense Department officials have kept Canadian officials advised of current thinking on the air defense problem. Although USAF's recent action triggered a debate on the subject in Commons, Canada is expected to go ahead with plans to construct two Bomarc-B bases at North Bay, Ont., and Mont Laurier, Quebec.

Decision to abandon plans for the SAGE super-combat centers also will have an effect upon the Federal Aviation Agency which was investigating the feasibility of using the expanded capacity of the new AN/FSQ-7A computers for integrated control of high altitude military and civil aircraft traffic.

Observers expect, however, that FAA and the Mitre Corp., which was investigating the use of SAGE computers under FAA and Air Force contract will reorient their studies for the possible use of existing SACE AN/FSQ-7 computers.

Recent shift in Air Force emphasis from air defense against manned bombers to ballistic missiles has generated speculation that there will be increased pressure on FAA to use SACE computers for traffic control and perhaps even take over their operation in another several years.

Glennan Estimates National Space Costs

By Ford Eastman

Washington—Total cost of the national space program over the next 10 years will be at least $12 to $15 billion, National Aeronautics and Space Administration Administrator T. Keith Glennan told the Senate Space Committee last week.

Appearing before the NASA Authorization Subcommittee headed by Sen. John Stennis (D-Miss.), Glennan said the 10-year program will require expenditures of more than $1 billion in Fiscal 1962 and upward of $1.5 billion annually within the next five years.

NASA has requested $915 million for Fiscal 1961, and authorization for this amount ahead has been cleared by the House Space Committee and approved by the House. Added to Defense Department estimates of $471.1 million for Fiscal 1961 military space projects, the NASA budget will bring the total cost of U.S. space exploration to $1.39 billion for the next fiscal year.

The $12 to $15 billion for civilian space work over the next 10 years will cover a wide variety of projects ranging from earth satellite launchings to deep space probes, lunar impacts and manned orbital flights, Glennan said.

The knowledge and experience gained from these experiments, combined with the development of more powerful booster engines and high energy upper stages, will lead to manned circumlunar flight early in the next decade, Glennan predicted.

Development of the 1.5 million lb. thrust Saturn clustered engine will give the U.S. a thrust capability in 1964 which Glennan believes will not be exceeded by Russia after that time.

He said his prediction was based on a "reasonable guess."

"Perhaps it is gratuitous to put the statement in there," he said, "but so many people have made life difficult for us because we were unwilling to say we are going to do this or going to do that that I think I am entitled to a reasonable guess that the activities we have underway at the present time are not going to be exceeded by the Soviet Union."

Glennan told the Senate group that "there gets to be a limit to these sort of things and where we have Saturn laid on as a basic rocket system of 1.5 million lb. we have upper stages that will be in the liquid hydrogen class which gives us a very high specific impulse. This should be a really powerful system. It ought to put up as much weight as anybody really would want to put up and I doubt that they [the Russians] will exceed that."

Glennan also told the subcommittee:

• Vice Adm. John T. Hayward, deputy chief of naval operations for development, was "not wholly correct" when he told the House Space Committee that aeronautical research was "going down the drain" because of NASA's emphasis on space (AW Mar. 21, p. 30). He said NASA has been responsive to each request for aeronautical research and that the agency is conducting research in this field on its own.

• **Budget Bureau** earlier had set a $550 million limit on NASA's Fiscal 1961 budget estimates which were only slightly higher than last year but that he would not accept the limitations.

• **First suborbital flight** of Mercury crewman is not being timed for "just before elections" in order to influence the presidential race. When everything is ready, the flight will be made "whether it is before or after" the elections.

• To provide backup boosters for all scheduled firings would almost double the cost of the space program. In case of a failure, the experiment will be postponed until it can be scheduled at another time.

• In the next few years, when Saturn becomes operational, emphasis will shift from big boosters and weight lifting capabilities to scientific experiments and manned orbital flights.

Dr. Wernher von Braun, director of NASA's new George C. Marshall Space Center at Huntsville, Ala., who said last year it would take the U.S. five years to match Russia in space capabilities, told the subcommittee that "in the area of scientific achievements in the field of space exploration we probably have caught up very well. In fact, many people believe we have produced more scientific knowledge with our smaller vehicles than the Russians with their much larger ones."

Dr. William H. Pickering, director of the Jet Propulsion Laboratory, informed the subcommittee that an attempt will be made within a month to launch the Project Echo 100-ft. inflatable sphere into orbit. The sphere will act as a reflector in radio communications tests between New Jersey and California.

In the House, Rep. Overton Brooks, chairman of the House Committee on Science and Astronautics, continued to take testimony on the proposed changes in the National Aeronautics and Space Act of 1958 under which NASA was created. Major changes requested include liberalization of the patent provisions, elimination of the National Aeronautics and Space Council and elimination of the Civilian-Military Liaison Committee.

Roy W. Johnson, former director of the Advanced Research Projects Agency, told the committee he did not believe any changes in the present space law are necessary. He said the space committee and others in Congress should not be too preoccupied with reorganizations, but should concern themselves with programs, goals and all-out defense against communism.

At the same time, Johnson warned Congress against "blindly accepting" all of the advice from eminent scientists. "I believe we lag in the missile and space fields," he said, "because of the bad advice given to us over the past dozen years."

Skybolt Cost, Timetable

Washington—Air Force Douglas Skybolt air-launched ballistic missile program may involve almost a billion dollars over a 10-year period, including research, development and production costs of the missile and modification to Boeing B-52s.

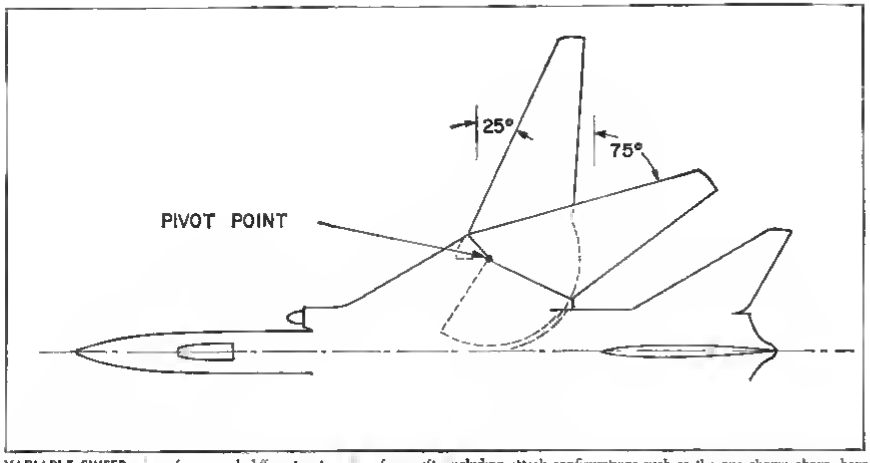
First squadron of B-52Hs is scheduled to be activated in 1965, with as many as 22 squadrons scheduled to carry the weapon to follow.

Plans are to develop and produce the Skybolt under a very tight schedule, with engineering changes held to a minimum.

Skybolt will have its external configuration changed as a result of design re-evaluation by Douglas and Wright Air Development Division, cognizant project office. Known as the Skybolt Delta version, the new configuration will eliminate the canard controls on the second stage (AW Feb. 22, p. 26), and four hydraulically-actuated movable fins similar in configuration to those on the Thor IRBM will be used on the booster stage. Control for second stage may be obtained through swiveling four exhaust nozzles.

Saturn Static Test

Washington—Static test firing of four of the eight engines clustered in the Saturn booster is scheduled this week. Dr. Wernher von Braun, director of the George C. Marshall Space Center, told the Senate Space Committee last week. If all goes well, he said, all eight engines will be test fired next week. Two of the eight engines were static test fired last week for eight seconds. Launch of the Saturn first stage with dummy upper stages is scheduled during the summer of 1961, while launch of a two stage vehicle is scheduled in the fall of 1962. A three stage vehicle will be launched late in 1963.



VARIABLE SWEEP wings for several different categories of aircraft, including attack configurations such as the one shown above, have been studied by NASA and a number of U S airframe manufacturers Stability and control problems of previous aircraft with variable sweep wings have been overcome through moving the pivot point well outside of the fuselage and by careful attention to design of the fixed root section Wing downwash over the tail is kept almost constant by moving the wing pivot outboard

Industry Reviews Variable Wing Potential

By J. S Butz, Jr.

Langley Field, Va.—Major improvements in the performance of variable sweep wings demonstrated by work at National Aeronautics and Space Administration's Langley Research Center are causing U S aircraft manufacturers to review these wing configurations which were generally rejected five years ago (AW Mar 28 p 29)

Researchers at Langley believe that over the past three years they have solved the fundamental problem of variable sweep wings—marginal longitudinal stability and control Using Langley work as a starting point, several U S airframe manufacturers are investigating variable sweep designs with the hope of achieving significant improvements in overall flight efficiency for all categories of supersonic aircraft.

If their work is successful, this form of variable wing geometry probably will be applied to vehicles which must fly at very high speeds but still land in the conventional manner

Today, most consideration of variable sweep is being made in connection with two types of aircraft that apparently are nearing the beginning of their development cycle Performance of both these aircraft can be substantially improved if the wing aspect ratio and sweep angle can be varied over a wide range. These aircraft are

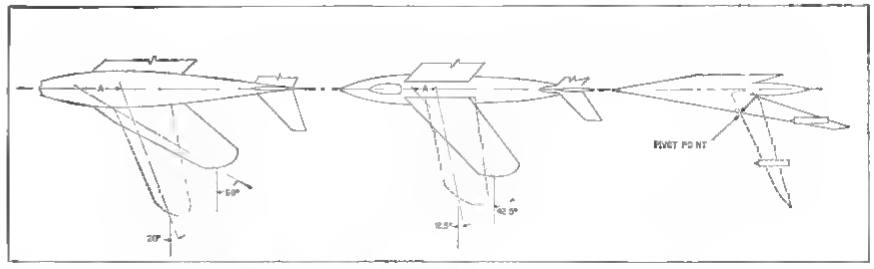
• **Supersonic transport** Takeoff performance and fuel consumption during subsonic climb to cruise altitude can be improved with the three to one increase in aspect ratio available through straightening the swept wings Normally, this portion of a transatlantic flight would consume 30% or more of the total fuel Capability of varying the wing sweep also should improve holding capability and performance during descent over the destination

• **Low level, supersonic attack** aircraft With its wings swept back around 80 deg to a point where its aspect ratio would be about 2.0 or less this aircraft would have almost a minimum drag coefficient for high-speed long-range flight at low altitude Gust loading in this type of flight would be significantly reduced with the sharply swept wings Its alternate configuration with straight wings and an aspect ratio approaching 6.0 would give it good takeoff performance and loiter capability as compared with that of swept wing aircraft Maximum ferry range and high altitude cruise performance also would be improved with the straight wing

Most of these theoretical benefits of variable sweep can be illustrated by three performance equations The first concerns the takeoff ground roll distance which is critical for all high-performance, swept-wing aircraft operating today Some of these are nearing the absolute limit with ground roll requirements of around 10,000 ft The takeoff distance can be reduced by increasing the engine thrust, the lift coefficient, the aspect ratio or wing area or by decreasing the aircraft weight

Supersonic transports of most current design proposals have their wing aspect ratios increased over the optimum for cruising flight in order to provide a manageable landing configuration Using variable sweep, it is considered possible to properly design these aircraft for cruise and still increase the aspect ratio and lift coefficient at the maximum usable angle of attack to the point where available lift during takeoff would be doubled

The second performance equation is that for gust loading, and it is of interest primarily for low-altitude flight where the combined effects of high speed, high air density and severe atmospheric turbulence can impose the greatest loads the structure will have to withstand The gust loads at any given speed can be reduced either by increasing the sweep angle, which, in turn, reduces the aspect ratio, or by increasing the wing loading of the aircraft If the wing is swept back to 80 deg, aircraft gust loads can be reduced by a large percentage over those with a 45 deg sweep, since the more highly swept wing has a smaller change in lift force per degree change in angle of attack



LAYOUTS of the experimental Bell X-5 (left) and Grumman F-10F aircraft (center) show that the intersection of the wing axis and the longitudinal axis of the fuselage were translated forward as the sweep angle changed to keep the aircraft from becoming too stable The X-5 was used to show that variable sweep wings were practical The F-10F a subsonic aircraft was flown extensively for the Navy but never reached production Butam's Vickers Swallow on the right is another variable sweep configuration considered in the last few years Adequate control power is one of its major problems as it was with the X-5.

An aircraft experiences atmospheric turbulence only as sudden changes in angle of attack and gust loads are lowered if the variation in wing lift per degree change in angle of attack can be reduced NASA reports indicate that the ideal vehicle for high speed low level flight is virtually wingless with a heavily loaded fuselage to keep gust loads to a minimum

The third performance equation is of main interest for supersonic transports during the climb-to-altitude phase of their flight Drag due to lift is critical during this time, and it is proportional to the reciprocal of the aspect ratio so that an increase in the latter from 2.0 to 6.0 will result in a large decrease in total drag during the climb out Supersonic transports probably will climb out at subsonic speeds to altitudes above 35,000 ft Recent studies have indicated that heavy ground damage from shock waves can occur if they do not Subsonic climb will make the fuel consumption problem more critical with highly swept low-aspect ratio wings

Efforts to effectively demonstrate the advantages of variable sweep began in the U S in the late 1940s through a joint project by the Air Force and NASA's predecessor, the National Advisory Committee for Aeronautics A group in NACA's Langley Laboratory did some of the preliminary thinking for the X-5, an experimental aircraft on which sweep could be varied in flight

Bell Aircraft Corp designed and built the X-5 which first flew in 1951 Purpose of the X-5 was to quickly and inexpensively demonstrate that variable sweep was practical A complete experimental flight test program with the X-5 showed that the aircraft had unsatisfactory stability and control characteristics, but it also pointed the way to corrections for these conditions

Major drawback in converting the basic X-5 design into a useful operational aircraft was the mechanism for varying the wing sweep. This elaborate mechanism was required to move the wing forward as the sweep angle changed As a result the mechanism was so heavy it would have penalized the performance of an operational aircraft more than the variable wing sweep would have helped it

On the basis of the X-5 flight program, the group at Langley Field decided that the weight problem could be overcome and a practical service aircraft built if it were possible to swing the wing around a simple pivot without moving it forward at the same time.

Fundamental Problem

Fundamental problem connected with increasing sweep angle by rotating the entire wing about a pivot point during flight is that the center of lift moves so far behind the center of gravity that the aircraft becomes too stable and it can no longer be controlled by a horizontal tail of normal size The center of gravity must be only a few inches ahead of the center of lift if an aircraft of current proportions is to have acceptable maneuverability This was the reason for moving the X-5 wing forward as sweep increased

Recent wind tunnel work on this problem at Langley resulted in configurations similar to the one illustrated on p 32 Here the pivot point was kept outboard far enough to allow 20% or more of the wing area to remain fixed and carry a large portion of the total lift when the wing was swept back

This feature plus a number of others involving wing twist and airfoil design in the fixed portion, resulted in a wing that would keep its center of lift from departing from the center of gravity in an unacceptable amount Center of lift on these wings moves almost straight inboard as the sweep changes Another feature of these wings is a slight increase in wing area when they are rotated for wind

Structurally, there are a number of ways in which this pivot can be designed to carry the loads of the outer wing section even though a thin airfoil section is used Three that have been considered in the U S and abroad are use of simple pin joints, spherical or ball joints and a pin surrounded by a large-diameter bearing plate

Shock Wave Damage Potential

Washington—An Research and Development Command is sponsoring studies to determine the exact extent of shock wave damage to be expected from low flying aircraft at supersonic speeds Such waves could provide a new means of destruction if low-altitude variable sweep aircraft prove to be a success.

It already is known that this damage can be severe since the increase in static pressure across a shock wave increases rapidly with speed Strength of the shock wave at ground level decreases rapidly as an aircraft gains altitude but extensive damage is expected from supersonic flights below altitudes of 100 ft

An example of the intensity of these pressures along the ground occurred recently when a Lockheed F-104 slightly exceeded the speed of sound about 50 ft. above the ground during an aerobatic display in Ottawa Canada, as it passed directly over a partially-completed $3 million terminal building The resultant damage was estimated at a minimum of $500,000 The incident has aroused the interest of agencies that set commercial building codes as well as that of the military

Current studies indicate that if an aircraft can fly at approximately Mach 1.2 only a few feet above the ground, the over pressure on the buildings along the flight path approach those near ground zero at Hiroshima

Titan Stretchout Plan Rapped in House

By Katherine Johnsen

Washington—Recent Air Force decision to boost the thrust and warhead size of the Martin Titan intercontinental ballistic missile and to switch to a non-cryogenic storable fuel system beginning with the eighth of the 14 squadrons now planned faces strong opposition within the House Appropriations Subcommittee on the Armed Services.

House opposition to the $400 million improvement program—of which $250 million is to go toward development of storable fuels—centers around the time lag between the operational dates for the first six liquid fueled squadrons and the remaining eight which are scheduled to receive the advanced Titan version. Of the total funds needed $119 million already has been allocated, including $46 million that has been transferred from the Convair Atlas ICBM program.

Delay will push the operational dates of the eight squadrons into the 1962-63 era of the solid-propellant Minuteman ICBM, and Subcommittee Chairman Rep. George Mahon (D-Tex.) suggests it would be preferable to buy larger quantities of the latter which he said are "cheaper and easier to handle." Minuteman cost is approximately half that of the $2 million for a Titan.

Maj. Gen. B. J. Webster, USAF deputy chief of staff for plans and programs, told the subcommittee that substitution of the Minuteman for the improved Titan is "frequently" discussed and that Defense Department opinion is divided on the issue. He added:

"I think our feeling is that we will need this number of heavy missiles over and above the Minuteman program in our force structure in the time period we are considering, that the heavier weight of the warhead has special uses that mean that the force structure should contain about this number of heavy missile squadrons and could not be properly substituted for by the Minuteman."

Mahon, however, argued that, regardless of refinements, it will be impossible to launch Titan or any other ballistic missile within the maximum 15 min. warning period that will be available until the late 1960s when the Midas satellite warning system providing a half-hour warning, is scheduled to become operational.

Air Force spokesmen appearing before the subcommittee were divided on the Titan decision.

Lt. Gen. Mark E. Bradley, Jr., deputy chief of staff for materiel, opposed it and recommended to the subcommittee that the $400 million be transferred to the North American B-70 Mach 3 bomber program, which was reduced to a $75 million research program for Fiscal 1961.

Maj. Gen. Osmond J. Ritland, commander of the Air Research and Development Command's Ballistic Missile Division, supported the Titan "upgrade" plan "from the long development point of view," with the qualification that there be sufficient operational missiles in the interim.

No Qualifications

Maj. Gen. R. J. Friedman, USAF comptroller, had no qualifications. "I was in firm support of going to the upgraded program," he told the subcommittee.

Rep. Mahon observed that money is the key to USAF's policy of constantly upgrading missiles. It postpones production, which is the area requiring the largest expenditures. He asked whether programs were stretched out to obtain more sophistication as a result of the fact that you did not want to spend too fast through an early time period anyhow. Gen. Friedman replied: "That is correct."

It also was disclosed that Air Force Secretary Dudley Sharp is considering a technically-feasible plan to upgrade the USAF-Convair Atlas to the capability of the upgraded Titan in connection with proposals for an expansion of the Atlas program. It was submitted to Sharp in early March. The upgrading would not be applied to the 13 Atlas squadrons of 10 missiles each now programed.

Strong support in Congress for more Atlas procurement to help close the Soviet missile gap is likely to dwindle if a decision should be made to upgrade the missile and stretchout deliveries beyond the gap period into the Minuteman era. Building up of the Minuteman operational hard force is scheduled to begin in mid-1962. In October, Air Force will decide whether to open a second Minuteman production facility, but this would not make it possible to bring the missiles into inventory at an earlier date in the 1961-63 period. It would, however, increase the number of Minutemen available by the end of 1964.

USAF reported the same total cost for the 13-squadron 130-missile Atlas program and the 14-squadron 140-missile Titan program—$4.9 billion. This includes funds for research and development, procurement and construction.

The Fiscal 1961 budget submitted by the President, which will be acted on by the House Appropriations Committee shortly, provides Atlas with $975 million, Titan, $788 million and Minuteman $368 million.

Other major topics on which the Appropriations Subcommittee on the Armed Services focused included:

- **Airborne alert.** Mahon already has predicted that Congress will boost the $90 million proposed by the President for an airborne alert program during the missile gap period of Strategic Air Command B-52 forces "by three or four times (AW Feb. 15, p. 26)." SAC commander Gen. Thomas S. Power has recommended that $600 million additional be made available for immediate implementation of an airborne alert. USAF Chief of Staff Gen. Thomas S. White has proposed an additional $385 million to build up "on the shelf capability" but not actually put aircraft in the air at this time. Gen. Power's program would require $801 million a year to maintain.
- **Increase in the fleet ballistic missile**

Atlantic Range Shifts

Washington—Pan American World Airways, contract operator of the Atlantic Missile Range, will absorb some 125 management and technical employes of Radio Corp. of America, its subcontractor for a number of technical services, during the next year.

Air Force has denied reports in the Florida area that there is a major dispute between Pan American and RCA over these anticipated transfers and says they are aimed at saving money, eliminating duplication and giving Pan American more direct administrative lines in certain planning areas.

Since Pan American also will take over some evaluation of technical equipment to be procured for use on the range, it is believed that the move may be aimed partly at removing RCA, which manufactures a variety of electronic equipment, from a position in which it might be accused of conflict of interest.

RCA employes will be offered the opportunity to change companies without losing seniority, etc. Negotiations leading to the transfers have involved heads of both companies.

Estimated cost of Pan American's cost-plus-fixed-fee contract for Fiscal 1960 is $81,865,000, plus a negotiated fee of $1.75 million. RCA's portion of the $82 million contract is approximately $27 million. In Fiscal 1959, Pan American's fee was $1.4 million on an estimated cost of $70.6 million. This amounted to 2.1% of the total cost or 4% of its own portion of the costs. RCA's fee was $800,000, or 3.34% of its $23,944,728 portion of the costs.

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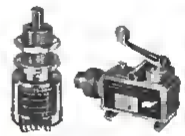
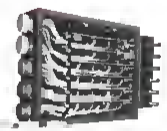

Environment Free and Hermetically Sealed Switches


Miniaturized Switches


Special Switches and Panel Components

program Vice Adm J T Hayward deputy chief of naval operations for development, recommended a five-year $7.2 billion program which would give Navy a total of 45 nuclear-powered Polaris missile submarines, nine of which are already financed The program would require $1.1 billion in addition to the $952 million proposed in the President's Fiscal 1961 budget The total cost $9.9 billion of which $2.7 billion has already been financed

• **Naval aircraft** Navy's proposal for a bigger procurement program to sustain the 7,200 operating aircraft it needs in its fleet has support in the subcommittee Navy reported this would require $1.5 billion for 681 aircraft in addition to the $1 billion for aircraft procurement in the President's budget

• **Increase Army modernization** program Army recommended $928 million in addition to the $1.5 billion now in the Fiscal 1961 budget requests Army estimated it will require an average annual investment of $2.8 billion from now on for modernization—about double the level of the past several years

• **Contractor costs and profits** Subcommittee members severely criticized the services for fraternizing with industry giving large contractors too big backlogs failing to redetermine contracts for cost reductions and allowing profits that have permitted the stocks of major contractors to skyrocket

Some people in the Pentagon have accepted favors and entertainment of considerable monetary value from contractors Mahon said When they do this they do not bring credit upon the uniform which they wear He observed that "probably the greatest threat to this country is not missiles in the hands of some opponent, but the moral decay of our own people

"There is no sense in our not getting more for the defense dollar in procurement We have lectured about it we have written reports about it, but those who run the programs have not done enough about it They just go ahead and pay and pay and pay, and the taxpayers who pick up the check do not like it I do not like it

Lockheed 1959 Sales Surpass $1 Billion

Lockheed Aircraft Corp joined the billion dollar sales volume club in 1959, but annual reports issued last week by it and by General Dynamics Corp showed the drag on profits exerted by research and development costs

• **General Dynamics**, the largest defense contractor in terms of sales volume, posted 1959 sales of $1,841,871,384 and a year-end backlog of $2.555 billion Though sales increased from $1.626 billion the year before, earnings dropped from $90,739,876 in 1958 to $54,156,069 last year

• **Lockheed** sales touched a record $1,301,565,000 for the company compared with $973,956,000 in 1958 but profits dropped from $18,845,000 in 1958 to $8,733,000 The 1959 figure represents a profit margin of only .7% on sales

Lockheed blamed increased costs and inventory write-downs on its Electra turboprop transport for the lower net earnings These rose from $9 million in 1958 to $16,044,000 last year reflecting in part that fewer orders were received in 1959 for the airplane than the company had projected

Not written off against earnings last year were most of the development costs of the JetStar small jet transport $30,505,000, a proposed supersonic transport $2,466,000 and the turboprop Super Hercules, $1,489,000 Since these are primarily military projects for which government support is anticipated $31,400,000 of this expense was classed as a deferred asset on the balance sheet on the supposition that the costs would be recovered

Lockheed reported backlog of $1,155,137 compared with $1,166,100 the year before Breakdown on the backlog was 26% commercial and foreign government sales including foreign F-104 orders, 35% missiles space and electronics defense orders and 39% airplanes ships and service defense orders This compares with a sales breakdown for 1959 of 29% commercial and foreign 42% missile space and electronics defense orders and 35% airplanes ships and service defense orders Last year airplanes represented less than 50% of the company's sales volume for the first time in its history

General Dynamics blamed not only increased development costs for its 880 and 600 jet transport programs for the pressure on earnings, but also increased expenses on certain unprofitable government developmental contracts and increased interest expense—up from $1,597,204 in 1958 to $6,205,385 last year—because of an increased level of borrowing Long-term debt rose from $90 million to $155 million last year and short-term bank debt from $34 million to $45 million

Lower development costs for the jet transport program were predicted for 1960

These rose from $24 million in 1958 to $43 million last year

Chairman Frank Pace Jr predicted stable or higher defense spending for the immediate future, but warned of added elements of risk in the company's long lead time programs because of rapid technological advances

Masefield Leaves Bristol

London—Peter Masefield, managing director, and Sir Matthew Slattery, chairman, resigned from Bristol Aircraft, Ltd last week Sir Reginald Vernon Smith becomes the new chairman and J T Harper assistant managing director replaces Masefield

Masefield has been mentioned in connection with two aviation appointments —the chairmanships of British Overseas Airways Corp. and the newly created Air Transport Licensing Board However the government has already asked Sir Matthew Slattery to succeed Sir Gerard d'Erlanger in the BOAC post

News Digest

U S-Soviet dispute over chairmanship apparently rules out the proposed international space conference which was to be held under United Nations auspices this year U S delegation is objecting to Soviet insistence that the conference should be run by a Russian and the dispute has blocked progress on an agenda and other issues in the UN Outer Space Committee With no agreement reached this late in the year, UN Secretary General Dag Hammerskjold feels it is too late to prepare for a meeting in 1960

U.S. and Britain agreed last week not to conduct underground nuclear tests with explosions of under 20 kilotons, which are presently undetectable if the Soviet Union signs an effective international control and inspection pact and joins in a research program to improve control methods for small underground explosions

Martin Co has received an additional $2.3 million from Atomic Energy Commission for work on isotopic power including Snap auxiliary power systems Total contracted to Martin for Snap work alone since early 1956 is now above $8.5 million Other work under AEC's Isotopes Development Office include design of a 5-watt generator to supply power for at least two years to an automatic weather station

North American X-15 No. 2 made its seventh and eighth flights last week On seventh flight plane was subjected to 2g negative after a 100-mm cold soak test On eighth flight wings and controls were subjected to simulated re-entry forces when pilot Scott Crossfield did a roll pullout under high grain forces

El Al Israel Airlines plans to buy two Boeing 707-420 jet transports for May and June 1961 delivery and to take an option on a third of the aircraft.

Jet Problems Key to 1960 Labor Talks

Turbine transport activity sparks union concern as airlines face new round of contract negotiations.

By Robert H Cook

Washington—Increased productivity of jet transports is establishing a new labor-management relationship that could touch off one of the bitterest disputes in airline history this year as the majority of the industry's present union contracts expire

An AVIATION WEEK survey shows that 11 of the 13 major carriers face new contract negotiations with the Air Line Pilots Assn, by fall Four of the 11 already are in either negotiation or mediation stages

Members of the Flight Engineers International Assn at six of eight trunk lines where the union is represented are now involved in various stages of contract discussions and negotiations which will extend to the end of this year

Airline hostesses represented by the Air Line Stewards and Stewardesses Assn are presently in arbitration with one major airline in a state of mediation with three trunk carriers and in negotiation with two others They also are opening contract talks with four other carriers and will begin talks with a fifth this fall

Seven of nine airline contracts held by the International Assn of Machinists, which represent the bulk of the ground maintenance and overhaul workers have a common expiration date of Oct 1 An eighth will expire on Dec 1, while the ninth remains in force until next spring

In addition to these key unions, there are 14 other AFL-CIO unions representing airline workers plus 8 independent unions Both groups cover trunk and local service operations with contracts that often overlap those of the larger unions

Local-Service Picture

On the local-service scene, the labor picture also is active but far less complicated since the smaller carriers do not operate turbojets and will escape a powerful array of union backed arguments against the trunk carriers

AVIATION WEEK's survey of 13 local service airlines shows that contract talks are concerned primarily with the usual issues of wages and working conditions

By the end of 1960, nine local-service carriers will have signed new contracts with ALPA At three other airlines, bargaining sessions are being conducted under the auspices of the National Mediation Board Two International Assn of Machinists' contracts will be negotiated this year and a third is now under negotiation

Outcome of a strike of the Air Line Employees Assn hostesses against Mohawk Airlines (AW Mar 28, p 39) is expected to affect the outcome of the ALSSA negotiations with seven other local service airlines whose contracts will be open for negotiation during this year

The Mohawk strike probably also will have a far reaching psychological effect upon ALSSA's dealings with trunk carriers since it was backed by ALPA pilots who refused to cross the picket lines Support from the pilot union is being interpreted by many industry observers as an indication that ALPA wants to make amends for the refusal of its pilot members to lend support last year to an ALSSA strike against Lake Central Airlines

Failure of the pilot union to support this strike almost resulted in the stewards union severing its affiliation with ALPA in favor of an independent AFL-CIO charter Industry observers also point out that pilots' backing of the Mohawk strike may indicate that ALPA will play a decisive role in ALSSA's negotiations with the trunk airlines Many issues confronting the two unions particularly those concerned with jet operations are similar

Labor views the operational capability of the turbojet transport as a direct threat to the purpose of union organization—job security

Already, with only a portion of the commercial turbojet fleet in operation, the Flight Engineers International Assn estimates 100 of its members have been furloughed as a direct result of jet operations ALPA reports that it has had 150 members furloughed at Eastern and 175 at Pan American World Airways (AW Mar 7, p 330)

Of equal concern to the unions is that the advanced speed of turbojet equipment has almost doubled the number of working days necessary for a crew member to acquire the maximum 85 hr a month flight time The engineers and stewards' unions also contend that jet flights cause extreme fatigue among their members (AW Jan 11, p 54) The charge is now being investigated by the Federal Aviation Agency

Added factors include the recent FAA ruling requiring the retirement of airline pilots at the age of 60, possibility that FAA also will rule that airline pilots may not transition to higher paying turbojet operations after the age of 55, ALPA's demands for more extensive copilot training and FEIA's insistence upon broader flight engineer training Observers believe the unions can use any one or all of these factors in collective bargaining demands for higher pay and less working hours

Narrowing Profits

At the same time airline management faced with a narrowing profit margin despite significant traffic increases and still relatively inexperienced in anticipating jet operating costs, can be expected to put up a stiff battle against any labor demands that might substantially boost operating expenses Several carriers believe that increased costs resulting from new union contracts could wipe out any revenue gains expected from a pending Civil Aeronautics Board decision in the three year old General Passenger Fare Investigation Case An indication of industry's intentions to stand firm is that National Northwest and Braniff recently added their names to the six-member mutual aid pact in event of strikes, signed in 1958 by Capital, Eastern, American Pan American, Trans World and United airlines The pact was approved for a one year renewal last November by the Civil Aeronautics Board National is currently in mediation with ALPA, in negotiation with FEIA and will soon begin talks with the stewards union

In an effort to counter the airline mutual aid pact, six key airline unions formed their own pact agreement last November Under the agreement, ALPA, FEIA IAM, the Air Line Dispatchers, the Transport Workers Union and the Brotherhood of Railway Clerks will try and work out a collective stand on the problems of hours and working conditions brought about by the introduction of jet aircraft Some members of the group have indicated that the union pact also is designed as a first step toward industry-wide bargaining

A concrete move in this direction was taken by FEIA last week when union officials met to formulate a "master contract" for use in industry-wide bargaining by its chapters with a common termination date for all current contracts Referring to terms of the airline pact, where carriers living the same routes as a struck member rebate part of their earnings to that airline, FEIA spokesmen said that their members will refuse to fly for carriers offering this aid

Realization of this common termination date by FEIA, labor authorities point out, would present the airline industry with a powerful combine of FEIA and IAM, which already has a common termination date for 7 of 10 of its airline contracts

Differing Opinions

ALPA, which threatened to move to industry-wide bargaining during CAB hearings on the airline mutual aid pact, now says it does not think this is suitable IAM spokesmen also say they will not push for industry-wide bargaining at this go around on its three year contracts because of differing opinions among its local chapters

At the same time, the spokesmen said they will not hesitate to support the strike efforts of the union pact members and that they follow the lead of FEIA in boycotting any carrier that goes to the financial aid of a struck member of the airline pact

Discussing its bargaining position among the trunk airlines IAM said most contract talks will involve wages and working conditions, and that, while it is losing some of its members as a result of the transition to jet aircraft, the losses are not considered a problem at this time

An IAM spokesman said, however that the union is "fearful of the total impact on job security" and cited National and Western airlines' leasing programs for Allison turboprop engines for the Lockheed Electra as a case in point Arrangements under which the two carriers return the engines to the factory for major overhaul, union officials contend not only cut the present percentage of maintenance work usually performed by IAM members but also could lead to further layoffs and eventual elimination of many maintenance jobs

Two other factors present in this year's labor situation which could further influence the labor problem, are the current FEIA-ALPA cockpit dispute and the growing strength of the Teamsters Union in the airline industry

FEIA officials, in announcing their plan to seek more pay for jet flights plus a lowering of maximum monthly flight times below the present 85 hr, said they "expect the usual opposition from management and a continuation of the raiding efforts of ALPA" but feel their demands will be realized this year

Seniority Lists

Reference to ALPA "raiding" was aimed at the insistence on the part of some carriers that FEIA members take pilot training and place themselves at the bottom of the pilots' seniority lists Such a situation exists at Continental Air Lines the union said, where talks have broken off and a strike may be forthcoming The engineers union has also charged that Continental attempted to force qualified jet flight engineers to relinquish their stations on scheduled Boeing 707 turbojet flights to copilots training as student engineers FEIA said it was successful in restoring one of its members to duty after he had been suspended by the company for two weeks for refusing to comply with this program

The engineers' union is facing similar problems at Eastern and National where ALPA has suggested to management that flight engineers join the pilots seniority list and that additional flight engineer training be provided ALPA members assigned to turbojet transports

FEIA terms the Continental situation as its "battleground" for 1960, but many labor observers feel a class and craft determination for United Air Lines now being heard by the National Mediation Board could have a much more significant effect on FEIA and the over-all question of crew complement

This action, which top AFL-CIO leadership attempted to ward off, was touched off by ALPA which asked the Board to determine if all flight crew members should not be described for collective bargaining purposes as a single class of "flight crew members" instead of pilot, copilot and flight engineer A Mediation Board ruling agreeing to the all-inclusive term would open the door for a vote that could lead to ALPA's gaining authority to negotiate all contracts for flight crew members

Final result of the Mediation Board action, labor spokesmen say, could establish a precedent for a demand by ALPA for a class and craft determination on other carriers using FEIA engineers

Teamster Union Growth

Adding to the airline labor problems this year is the increased activity of the Teamsters Union which has succeeded in expanding its entry into the industry by representing a block of several hundred stock clerks at Pan American, the navigators at Trans Caribbean and some West Coast-based ground and clerical workers of Trans World Air lines and the Flying Tiger Line One of the stated purposes for organizing the union mutual aid pact, its members say, is to fight the inroads of the

Contract Expiration Dates

	ALPA	FEIA	IAM	ALSSA	TWU
American	6/ 1/61	4/30/63		mediation	9/30/60
Braniff	4/ 1/61		10/ 1/60	negotiation	
Capital	12/ 1/60		10/ 1/63	mediation	
Continental	12/31/60	5/ 1/60		5/31/60	
Delta	12/31/60				
Eastern	4/ 1/60	6/ 1/60	10/ 1/60	1/31/60	
National	mediation	negotiation	10/ 1/60	3/31/60	
Northeast	negotiation		12/ 1/60	1/31/63	
Northwest	mediation		10/ 1/60	negotiation	
Pan American	8/ 4/60	6/ 1/60			12/ 1/60
Trans World	11/22/60	1/ 1/61	12/ 1/63	arbitration	
United	11/ 1/60	6/ 1/63	12/ 1/60	mediation	
Western	10/ 1/60	1/ 1/61	3/31/61	12/31/60	

Table above shows present status and contract renewal dates for major trunk carriers and Air Line Pilots Assn., Flight Engineers International Assn, International Assn of Machinists, Air Line Stewards and Stewardesses Assn, and Transport Workers Union of America Maintenance personnel at American are represented by the TWU and at Continental by a division of the United Auto Workers under a UAW contract scheduled for renegotiation by a Dec 1, 1960, deadline Delta has only ALPA, which also negotiates for company flight engineers, while wage and working conditions for the balance of unorganized, non union personnel were opened on Jan 1. Flight engineers also are represented by ALPA at Braniff, Capital and Northeast and by the IAM at Northwest At Pan American, collective bargaining contracts for both mechanical personnel and hostesses are conducted by the TWU.

Teamsters in the expanding air freight field.

Although emphasizing that they are concentrating on the large group of unorganized workers in the air freight field, the Teamsters add that they have played an active role in past airline labor disputes in terms of support and money.

One year ago in the IAM and FEIA strike against Eastern, the Teamsters honored the picket lines of the unions and backed a $250,000 loan for the engineers. Surveying the airline labor status this year, a top Teamster official said: "I imagine they will ask our help."

The union says it feels recent labor legislation has promoted a need for industry-wide bargaining and that this can be legally accomplished with common contract dates covering a master union agreement. Since each local would be entering into an individual strike, the question of a secondary boycott violation of labor laws could be technically avoided, Teamster spokesmen say. Industry-wide bargaining on common contract expiration dates now exists with Teamster locals in an 11 state-area in the West, according to the union.

While ALPA headquarters recently censured attempts of a group of TWA pilots who wanted to make lower monthly flight times a bargaining issue on the airline in exchange for dropping current contract requirements for a third pilot on jet transports (AW Feb. 8, p. 38), most observers feel that the pilots may yet make this flight time reduction an issue in view of FEIA and steward union demands for an hourly reduction.

At the same time, the pilots' union says it has another time problem on Pan American World Airways involving excessive flight deck duty on international flights. Pilots have complained of spending as much as 16 hr. at aircraft controls with 20 to 32 hr. of duty time, although present FAA safety regulations permit the scheduling of two pilots for flight duty of up to 12 hr. on international flights. ALPA concedes that the matter of time scheduling permits Pan American to comply with the regulations but says the company has not acceded to union wishes to reduce the time problem pending possible revision of the FAA regulation.

When 240 Pan American pilots passed a resolution refusing to accept any flight scheduled for more than 8 hr. of flight deck duty time in any 24 hr. period, the airline issued subpoenas against them and was scheduled to seek a court injunction last week that would prohibit the pilots from carrying out their intentions.

Infighting between ALPA and FEIA over crew complement and training issues could cause a particular hardship on many carriers where contract expiration dates for the two unions are the same or fall close to one another.

A case in point is Eastern where the major issue is flight engineer training. FEIA compares the situation with Continental and Eastern was forced to obtain a court injunction against ALPA members when they threatened to refuse to fly the Douglas DC-8 unless given extensive engineer training. The company and its pilots have now agreed to arbitration on this point by Apr. 15. FEIA has objected to expanding engineer training for the pilots and, in turn, is demanding greater training time for its own members.

National is in a similar position where engineer training and crew complement questions have resulted in FEIA awaiting for mediation while the pilots are still in negotiation with the company.

To avert such training problems in the future, FEIA has formed a basic contract for its members calling for a minimum of six weeks ground school training as compared with the three to five weeks now provided by most carriers. The union wants industry-wide retirement standards for its members at the age of 60 and while it has not yet revealed an actual figure, it also probably will press for a monthly flight time limitation of 60 hr.

Major new target of both FEIA and ALPA will be Western Air Lines because of its recent announcement of plans to purchase jet aircraft. Jet pay and crew complement will be an issue for both unions.

Current arbitration hearings between Trans World Airlines and the Air Line Stewards and Stewardesses Assn. is expected to set the pattern for the balance of ALSSA contracts still unsettled in the trunkline industry. ALSSA wants a 15% pay differential for jet duty plus a lowering of monthly flight hours on a formula which could result in only 65 hr. a month for its members.

Basic formula under study would drop one minute of required flight duty time for each 10 mi. per hour that jet aircraft speed exceeds 300 mph. Fatigue is a major issue here, with ALSSA estimating that many of its members are now forced to make as many as 15 jet flights per month as compared with only 6 on piston aircraft, in order to meet the present 85 hr. monthly flight time.

House Group Backs MATS' Bid For Cargo Fleet Modernization

Washington—Air Force's Military Air Transport Service appeared well on the way toward realization of its fleet modernization program last week following a recommendation by the House Armed Services Subcommittee to a House Appropriations Subcommittee that MATS airlift needs be considered a matter of vital priority.

Backing his earlier promises to support the MATS programs, Rep. L. Mendel Rivers (D-S.C.), chairman of the House Armed Services Subcommittee, asked in the name of his subcommittee that MATS be granted $50 million in the Fiscal 1961 budget for fleet modernization and initial costs toward eventual development of a turbofan "workhorse" cargo transport. Rivers added that MATS also should be permitted to purchase cargo versions of the Boeing 707 or Douglas DC-8 turbojet transport as an interim aircraft, pending development of the workhorse design (see p. 50).

Strong indications that MATS will use part of any modernization funds for DC-8s or 707s also were contained in the testimony of Lt. Gen. Mark E. Bradley, Jr., USAF deputy chief of staff for materiel, who told members of the House Appropriations Subcommittee that it has not yet been decided whether MATS should have a new cargo aircraft or modernized, cargo versions of a design already in existence.

We may go into a fairly short range development program that would actually get some hardware for this money," Gen. Bradley said, adding that modification of the DC-8 or 707 designs "may do the job quicker and cheaper."

Rivers' recommendation that MATS purchase a modification of existing turbojet equipment plus Gen. Bradley's testimony that DC-8s or 707s may be purchased as an initial step toward modernizing MATS airlift capability, is being regarded by most airlines as a definite threat to their hopes for development of a new cargo aircraft acceptable to both military and civilian users. Carriers generally fear that congressional zeal in supporting MATS immediate aircraft needs may result in an indefinite shelving of military plans to develop a "workhorse" aircraft.

Quesada Objects

Much of the airline concern arose in the wake of testimony before the Rivers subcommittee by Federal Aviation Agency Administrator Elwood R. Quesada.

Quesada raised strong objections to any purchase of cargo versions of either the 707 or DC-8 and urged that MATS select a Lockheed C-130B type aircraft for interim use, contending that the turbojet designs would prove too costly to operate. In addition, he said that, while the Canadair CL-44D is the only cargo designed aircraft now available for use, it is a "compromise" that is "very, very far from an uncompromised cargo aircraft" needed by both military and civilian users.

Estimating that it would take four years to obtain a cargo plane that would meet the Air Force's specific operational requirements, Quesada told the committee FAA is still working with both the airlines and military in hopes of finding an acceptable design.

Quesada also estimated that an acceptable design for a workhorse aircraft could be obtained within four months if the purchase of 707 and DC-8 cargo versions were discouraged. "This would make them [manufacturers] go at it pretty hard," he said and could lead to shorter delivery times since the manufacturers are "very, very, hungry for business."

Repeating his objections to accepting any modification of existing turbojet models for cargo purposes, Quesada noted: "We wouldn't have a trucking industry today if it were built around a modified bus.

Part of the development cost of a new cargo aircraft could be assumed by commercial carriers, he said, in much the same manner as sums repaid to the government by Boeing Airplane Co. for development of the KC-135 jet tanker. A provision for repayment should be made not only when industry buys the aircraft after heavy government development costs but also should be applied today where Boeing 707s are being retrofitted with turbofan engines, the administrator said.

"In my opinion, to purchase these aircraft to meet cargo needs would be a step in retrogression and ignores the unique opportunity to have both the civil and military fleets benefit from an uncompromised cargo design for which they now have a concurrent need," Quesada said. He added:

"It is understood another proposal has received some attention, which is to buy KC-135 tanker aircraft for MATS and remove the tanker equipment. It would be difficult to imagine a more illogical thing to do. A series of lash up modifications would follow, such as swing the tail to correct loading problems. Then later the installation of turbofan engines would become a critical need to reduce runway requirements and so on.

"All this would not only be time consuming and a waste of money, what is more important, the end product would be far from what is needed. Buying anything other than an uncompromised cargo aircraft runs counter to the objective of equipping MATS with the proper equipment for its wartime job.

"If we compromise the military fleet now, it will have been compromised for the next decade."

Praising the operations of the Strategic Air Command and criticizing MATS' operations, the FAA administrator said that, while MATS carried 530,000 military passengers in the one-year period ending last July, it also carried 390,000 civilians and 93,000 non-revenue "hitch hikers." He added that the only strategic airlift made within the past five years were the recent flights to Puerto Rico.

Replying to a committee remark that the Puerto Rican airlift cost $10 million and required seven months of preparation, thus indicating MATS modernization needs, Quesada said they should have been able to have done it within a week. And, if they can't arrange for it within a week, why call it a strategic move?"

Quesada said that MATS daily utilization rate of five hours was unnecessary and compared it with the training record of SAC which, he said, maintains its readiness with a utilization rate of one and a quarter hours. He added that most of MATS actual training value is gained at the beginning and end of each mission, with the in-between long periods of straight and level flying providing little experience. Referring to the disparity of utilization rates between the two commands, Quesada said that, since SAC can launch an attack within an hour, MATS should be prepared to do as well. Rivers later disagreed with Quesada's stand on MATS' utilization rate on the basis of the "best military advisers we can find."

New FAA Speed Limits on Electra Force Airline Schedule Changes

Washington—New Federal Aviation Agency operating restrictions on the Lockheed Electra are forcing air carriers into schedule changes and some adjustments in route patterns of the turboprop transport.

Most of the seven carriers operating the Electra which by late last week had two speed restrictions placed on it limiting the aircraft to 225 kt. since the Northwest Airlines accident last month at Tell City, Ind. (AW Mar. 28, p. 40), are not revising printed timetables since the restrictions are considered an interim measure. Majority of the airlines admitted to some traffic decline on Electra flights.

American Airlines Electra flight times were increased by 10 min. on the New York-Boston run, for example, and by 25 min. on the New York-St. Louis flights. Western said its flight times have been raised by about 7 min. per hr.

Sliding Scale

Eastern used a sliding scale in the adjustment of its flight times. Flights of 200 mi. were increased by one min., 800 mi. by 14 min. and 1,700 mi. flights were increased by 32 min. The airline said it would not operate Electra flights beyond an 800 mi. range after Apr. 24, date of major schedule changes for all airlines.

American will cancel 14 of its 128 daily Electra flights to prevent a shortage of flight crews caused by the speed restrictions. Eastern, after Apr. 24, will add Electra flights to 7 new cities since, by limiting flights to ranges less than 800 mi., the carrier will have an excess supply of Electras.

It was too early last week to determine whether direct operating costs will be affected by the speed restriction. However, it was generally agreed that fuel costs probably would climb with the reduced cruising speed in effect.

Here are the steps FAA has taken thus far:

- New airworthiness directive lowers normal operating speed of the Electra to 225 kt. at normal operating altitudes. The restriction provides a margin of safety which is judged in terms of reduced dynamic pressure. The relationship of dynamic pressure at 275 kt.—original cruising speed of the aircraft—to that of 225 kt. is a ratio of 1.5 to 1. Consequently, an additional airload margin of 50% exists at the new speed between the maximum loads.
- Electra autopilot is to be deactivated until FAA-approved modifications are incorporated.
- Manufacturer's refueling procedures are to be observed to prevent possible damage to the wing structure.
- Airlines must conduct an immediate structural inspection of the entire wing and center section of each aircraft. Structural inspections are to be conducted following any flights that have experienced severe turbulence or hard or overweight landings.
- FAA air carrier inspectors have been ordered to increase inflight inspections of the Electra.
- Proposed rule making has been issued that would require the installation of flight recorders on all turbine-powered aircraft by Sept. 1. At present, only turbojet aircraft are required to be equipped with the recorders.

Meanwhile, as first reported by AVIATION WEEK (AW Mar. 28, p. 40), Lockheed Aircraft Corp. has undertaken engineering and research investigations

of the aircraft and with the FAA, assisted by the National Aeronautics and Space Administration, is conducting a technical review of all design aspects.

Basic strength criteria will be reviewed by Lockheed, including tests involving continuous stresses to be applied to the complete destruction of an Electra wing and powerplant structure. In addition to the static tests, flight test measurements will be conducted.

Meanwhile, Electra operators were optimistic over the probabilities of finding a solution to the Northwest and Braniff accidents which, according to FAA, were similar in character. Once the causes of the accidents are learned and corrective action is taken, the operating restrictions will be lifted.

On the other hand, FAA Administrator E. R. Quesada stressed that new limitations and restrictions will be immediately imposed if results of the tests and inspections so justify.

Restricting the Electra has had a direct influence on the used plane market. An AVIATION WEEK survey indicates there is now a sudden reluctance on the part of Douglas piston-engine aircraft owners to lease their airplanes or sell them under liberal credit terms.

One dealer told AVIATION WEEK that one airline has been offering planes with liberal terms or lease arrangements but now won't consider a lease and will consider a sale only if the terms are satisfactory to the seller. Another airline representative who one week ago said "I'm asking $700,000 but give me an offer" for a Douglas plane now says, "the price is $700,000."

TWA Profits Reverse 1958 Net Loss

New York—Trans World Airlines' consolidated net profits for 1959 totaled $9,402,000, second highest in the company's history and a strong reversal of the $1,764,000 net loss in 1958.

TWA's gross revenues totaled $348,458,000 last year, a 22% increase. Operating profit was $17,263,000, compared with a 1958 net operating loss of $375,000.

Final 1959 figures for several other airlines include:

Eastern Air Lines grossed $298,307,424 in operating revenues, with net earnings of $7,103,071. The airline earned 9,566,922 passengers during the year. Operating expenses totaled $282,923,900, up from $234,950,769.

Western Airlines reported 1959 net earnings after taxes of $5,016,656, as compared with $1,402,340 for 1958, despite an almost four-month labor strike between last Feb. 21 and June 10.

The airline had total revenues of $63,253,971 in 1959 as compared with $33,970,204 in 1958. Expenses rose from $32,914,413 in 1958 to $52,213,372 last year.

Continental Air Lines has reported a net income of $1,700,080 in 1959, as compared with a loss of $132,355 in 1958. The carrier reported total operating revenues of $45,983,531 for 1959, as compared with $28,455,307 in 1958. Operating expenses were $42,130,389 last year, $27,417,195 in 1958.

United Air Lines reports 1959 net earnings of $13,798,621, a decline from the $14,300,262 posted in 1958. Revenues totaled $330,155,751 for 1959 up from $319,961,279 in 1958. Total expenses for the airline rose from $286,262,924 in 1958 to $308,326,559 last year.

New Decca Computer

Decca Navigator Co., Ltd., reports that it has developed a digital computer which automatically converts Decca navigation system data from hyperbolic to rectangular coordinates to provide an "undistorted pictorial display" with automatic chart change. Computer also provides a left-right steering indication similar to VOR (omnirange), and permits navigation system to be coupled directly to airplane's autopilot.

The development presumably is intended as an answer to critics who have pointed out that VOR provides left-right indication, autopilot coupling and an undistorted coordinate system for pictorial display. The new digital computer, called Omnitrac, also can operate from rho-theta system inputs. Computer will occupy about one cubic foot. Company does not say when new computer will be commercially available, but notes that space has been provided for the new type of distortionless display in Britain's new de Havilland DH 121 jet transport.

Medical Aspects Cited In Crash Testimony

Washington—Civil Aeronautics Board investigation indicates that the copilot of an Allegheny Airlines Martin 202 that crashed near Williamsport, Pa., last December had suffered a coronary occlusion prior to the crash. CAB also found the pilot of a Piedmont Airlines Douglas DC-3 that crashed near Charlottesville, Va., on Oct. 30 had used tranquilizers (AW Dec. 21, p. 87).

Oscar Bakke told a House Appropriations Subcommittee that these two circumstances were not necessarily the causes of the two accidents. Bakke, who testified as chief of the CAB Bureau of Safety, has since transferred to the FAA is director of flight standards.

Bakke said the pilot of the Piedmont DC-3 had taken his personal problems to a psychiatrist and "as a matter of fact, shortly before the accident, was consulting a second psychiatrist. . . ." Bakke also revealed that the pilot had a prescription for tranquilizers for six weeks prior to the crash and that on the basis of the second psychiatrist's estimates they should have relieved the pilot's depressions up until the day before the accident. Bakke said, "As best we were able to determine, this medication would not have been available to him the day before the accident."

In the Williamsport crash (AW Dec. 7, p. 35), Bakke said an autopsy of the copilot revealed an ". . . unusually severe occlusion of the coronary arteries." He estimated the occlusion to be about 90%.

Bakke said the copilot was still alive at the time of impact and that the autopsy apparently was not able to determine whether the copilot was having a heart attack. Bakke said "it is quite possible, however, for him to have been afflicted with a severe seizure—angina—which might have been sufficiently severe to immobilize him."

Bakke said this possible attack could have caused the copilot to fall into the controls diverting the pilot's attention, and that while this was taking place, the aircraft could have drifted off course toward a nearby mountain. Bakke added, ". . . in a matter of 12 to 15 seconds later when he focused his attention upon the operation, it had become apparent to him that he was flying toward this high mountain. It was then too late for him to recover."

Hector Proposals Rejected by CAB

Washington—Civil Aeronautics Board last week opened fire against proposals made last fall by Louis J. Hector in which the former Board member suggested substantial changes in the system of federal independent agencies (AW Sept. 21, p. 38).

In a 92-page document prepared by the Board's office of general counsel, the CAB took issue with and renounced virtually every point raised by Hector in his original memorandum, which was filed with President Eisenhower when he resigned from the Board (AW Sept. 21, p. 36). In offering its counter charges the CAB promised its statements in this manner.

"The Hector position is extremely general and lacking in explanatory detail concerning the practical application of his proposal, so that particularized comments on this score are virtually impossible." Board added that because Hector's program "embraces basic principles concerning government regulation of air transportation with which we vigorously disagree, we are taking this occasion to make our views known."

Losses Force Capital to Ask for Subsidy

By L. L. Doty

Washington—Capital Airlines buffeted during the past three months by a series of net losses and sharp declines in traffic, has petitioned the Civil Aeronautics Board for a return to air mail subsidy.

In its petition, the airline said unusually severe operating weather and a series of major air accidents were principal factors behind its current fiscal plight which brought about a $1.3 million net loss in January and a $2.1 million loss in February. Early estimates place a net loss in March at approximately $4 million.

Emphasizing in its petition that its current cash position is critical, Capital asked for an immediate subsidy mail rate of 22.5 cents per revenue plane mile for the entire system which, according to the petition, would increase operating revenues by an estimated $12.9 million for the year ending Mar. 15, 1961.

If the request for subsidy is granted, Capital will be the first carrier of the 12 domestic trunklines to operate under a subsidy mail rate since Jan. 1, 1959, when Northeast returned to a service mail rate. At present, there are no palpable signs that the fiscal condition of any one of the other trunk carriers is serious enough to warrant it taking similar steps toward financial relief.

However, many observers are not discounting the likelihood that carriers whose reserves are not sufficiently strong to carry them through economic setbacks may be forced to either petition for subsidy or seek out mergers for survival.

Earnings Decline

Most carriers are expected to show depressed earnings or net losses for the first quarter of the year. In January alone, 5 of the 12 trunklines reported net losses to the CAB.

Gross revenues in March probably will suffer to some degree because of operating restrictions placed on the Lockheed Electra (see p. 43). If the trend toward lower profits persists and if traffic should fail to grow throughout the year at rates originally forecast as the available seat miles increase, the present complexion of the industry could change drastically within the next few years (AW Dec. 28, p. 26).

Capital's relative position with respect to the industry has been unique in that, although its net losses have followed a general industry trend, it has suffered traffic declines while the rest of the industry showed increases. In January, it was the only carrier to experience a reversal in the upward surge in traffic and, in February only National Airlines and Capital reported a traffic decline.

In January, trunkline revenue passenger miles increased 17% over the previous January and February revenue passenger miles climbed 12%. This month—rising traffic coupled with declining earnings—is attributed generally to a high expense level resulting from heavy transitional equipment costs—particularly those which become of their current nature are not being capitalized for amortization.

Annual Report

Capital's expenses reached $105.2 million in 1959. Since the airline was grounded by a labor strike for slightly over a month in 1958, no basis for comparison between the two years exists. With respect to unit costs, the airline has this to say in its annual report to stockholders:

"During 1959 when the expansion of its services was limited by the inability to acquire additional equipment, cost increases could not be absorbed through increased productivity. Capital had to absorb these cost increases over almost the same seat mile base it produced in the 12 month period preceding the strike, with the result that unit cost of producing a seat mile of transportation rose from 3.67 cents for that period to 3.92 cents in 1959."

Capital's net loss for the year was $1,755,425 as compared with a net profit of $213,262 in 1958. Total operating revenues for the year were $108.4 million. In its subsidy petition, the airline forecast operating revenues of $108.3 million and a total net loss of $9.7 million for the year ending Mar. 15, 1961.

Capital's cash position, which stood at $5.8 million as of Dec. 31, has been seriously affected by the continuing losses, according to one company spokesman, who added that, although it is having no immediate problem in meeting current expenses, the airline could face difficulties within 60 days unless the subsidy is granted.

Re-Equipment Delay

In addition, Capital's financial program for the purchase of a fleet of Lockheed Electras and Convair 880s (AW Feb. 1, p. 30) "will be delayed for an indefinite period of time." The airline had hoped to improve its competitive position on its major routes with Electra service at the start of summer.

Capital cited a number of "abnormal" factors beyond the control of management that have caused the company to incur substantial operating losses and then added:

However of more immediate and cumulative effect, last week's tragic Electra accident in Indiana—resulting in an FAA order temporarily limiting the aircraft's operating speeds—makes it impossible at the present time for Capital to perfect the debt and equity financing program which Capital has been arranging for the purchase of its new equipment.

Capital is automatically placed upon an open mail rate coincident with the filing of the subsidy petition. Meanwhile, just how favorable the climate is for adding to subsidy costs at this time remains to be seen as the petition is processed in the CAB's mail rate section.

If the Board should grant the subsidy, it would be required to go before Congress to request new funds in addition to the $68.1 million already requested for subsidy payments in Fiscal 1961, and Congress has regularly questioned the need for subsidy. On several occasions, congressional committees and subcommittees have shown impatience with rising subsidy costs and have persistently asked the Board when it expects the industry will reach a self-sustaining basis.

Conservative Approach

In addition the Board has indicated that it is now taking a conservative approach toward subsidy requests. During recent House Appropriations Subcommittee hearings the Board in discussing subsidy requests of the two Hawaiian carriers noted that "we are far from certain that they will get subsidy."

Meanwhile, Charles Murchison, who controls some 80,500 shares of common stock and is chairman of Capital's powerful executive committee of the board of directors, has been named vice chairman of the airline. Observers here feel that Murchison may soon replace George Hann as chairman of the board in a move designed to give him more direct control of the company's operations.

Last week, Capital furloughed a total of 197 mechanics at its main overhaul shops here where a total of 1,830 mechanics are employed.

The carrier gave these reasons for the 10.7% cutback:

- **Lockheed 049 Constellations** will be phased out of service by July 1.
- **Plans to revise configuration** of the Vickers Viscount turboprop transports from 44 to 50 seats now have been deferred.
- **Delay in delivery of Lockheed Electras** has reduced the need for mechanics.

Hypersonic Airliner Proposed for 1980s

Los Angeles, Calif.—Hypersonic boost-glide transport envisioned for the 1980-90 era which would fly at speeds up to 15,000 mph. and carry 30 passengers from Los Angeles to Capetown, South Africa (10,165 mi.) in 1 hr. 22 min. was proposed here by Leston Faneuf, board chairman of Bell Aircraft Corp.

Ideal altitude for the transport would be between 12 and 100 mi., which would be relatively free of traffic in this area. Space below would be crowded with subsonic and supersonic aircraft, while satellites would orbit above this distance, he noted.

Carried piggyback to 120,000 ft. altitude on a six-engine turbojet-ramjet boost vehicle, the transport would be mounted on guide rails as it lights off its 165,000 lb.-thrust rocket engine required to develop the plane's flight speed and altitude. Faneuf described the combination transport in the opening lecture of a series on "Peacetime Uses of Space" being sponsored by University Extension of the University of California.

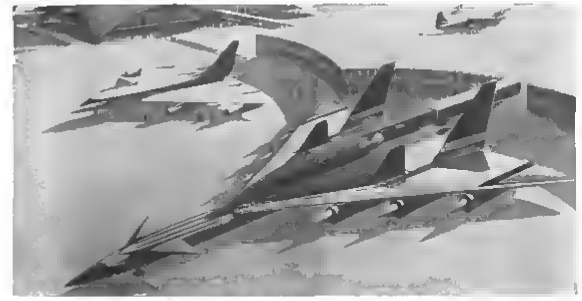
Boost-glide transport would be 88 ft. long and would weigh about 160,000 lb. at launch from the mother ship. Burning about 105,000 lb. of hydrazine and nitrogen tetroxide propellants over a 4 min. engine run, the transport would reach an altitude of about 43 mi. and peak front-to-back acceleration of about 3g. Two pilots, and perhaps a cabin attendant, would be used.

No breakthroughs in the state of the art are required for this type of transport, Faneuf said, but a 15-year concerted design-development cycle would be needed, with a total cost of about $1 billion.

Government backing would be necessary for development, Faneuf believes, and operations would have to be carried out as joint ventures by groups of airlines because of hardware cost. Based on an estimated construction cost of $67/lb. for the boosters and $100/lb. for the transport, one operation to cover a 10-city international network might require 40 transports at $4,700,000 each and 20 boosters at $15,800,000 each, a total of $504,000,000.

Combined per-flight costs of $9,660 for the booster, $9,240 for the transport and a profit of $3,000 would set total cost per flight at $21,900.

Calculations show, according to Faneuf, that for a range of 4,000 mi., the total fare would be $710 per passenger, to include direct and indirect operating costs and a profit (development cost is not included). For 6,000 mi. total fare would be $730, while the same values for 8,000 mi. and 10,000 mi. trips would be $750 and $770.



BELL AIRCRAFT CORP. artist's conception of a hypersonic transport shows the rocket powered vehicle attached to an air breathing booster similar to the North American B-70 bomber (AW July 14, 1958, p. 26) except for engines, which resemble Marquardt ramjets. Transport would be designed for air launching. Supersonic transport at left is similar to Convair B-58 bomber in configuration. Vertical takeoff and landing aircraft in background has tilting rotors similar to Bell Helicopter Corp. XV-3 Convertiplane's (AW Oct. 5, p. 124).

Configuration of the boost-glide vehicle would place crew and passengers up front, with propellant tanks and gimbaling rocket engine at the rear. The transport also would carry a small turbojet engine and fuel for maneuvering at landing, when the vehicle would weigh about 55,000 lb. Landing speed would be 180 to 200 kt. A highly swept delta wing with a lift-drag ratio of about 2.5 would be used but, beyond this, there is no agreement among experts on best shapes for the vehicle.

The transport structure would feature refractory materials on the leading edge of wing and nose to withstand temperatures up to 2,500F for re-entry (AW Mar. 28, p. 98). Rest of the structure would have a double wall-type heat shield, with sandwich panels of high heat resistance on the exterior, a layer of insulation and an inner, load carrying structure of conventional materials.

An inertial guidance system would provide data for a completely automatic flight control system from engine ignition to touchdown, although backup manual controls would be provided for the pilots. Attitude control out-of-atmosphere and during re-entry would be accomplished by nose and wingtip rockets. A tape carrying commands for all parts of the flight would be used in an on-board computer to operate the automatic flight control system, including the energy management function as well as attitude programing.

Airframe, rocket and turbojet engines and tanks would weigh a total of 47,000 lb., propellants (for 6,000 mi. trip) 105,000 lb., and payload (30 persons and baggage), 8,000 lb.

Transport cost breakdown per flight would show an airframe depreciation of $940 ($,000 flights amortization, original cost of $4,700,000), a propellant cost (for 6,000 mi. flight) of $6,300 at six cents per pound total (for 25 yr. from now), and other costs (crew, maintenance, insurance, overhead) of $2,000 per flight for a total of $9,240.

Boost vehicle, of canard delta configuration would be 200 ft. long, have a 150 ft. wing span, a high finess ratio and would carry enough fuel for its boost mission and return to earth. Supersonic turbojets would be located in front with an air bypass around to the ramjets at the rear, in each pod. Sea level thrust would be 50,000 lb. for each engine. Power would be enough to accelerate the booster and glider together to 5,300 mph. at 120,000 ft. for glider (transport) launch.

Booster plane weight summary shows airframe of 236,000 lb., fuel (for boost and return) of 354,000 lb. and payload (the hypersonic glider transport) 160,000 lb. Airframe would use conventional materials, since the high aerodynamic heating period would be fairly short.

Booster cost breakdown shows airframe initial cost of $9,660 pro rated over 10,000 flights at 1,580 per flight, a fuel cost of $7,080 (at two cents per pound) per flight, and crew salaries, maintenance, insurance and all other overhead allowance of $1,000 per flight.

The 750,000 lb. combined booster-transport would lift off conventional runways in 5,800 ft. Subsonic climbout would be made to 40,000 ft. Supersonic climb would be made from 40,000 ft. to 120,000 ft., toward the destination.

'Big Slam' Tests MATS Airlift Concepts

By David H. Hoffman

San Juan, Puerto Rico—Exercise Big Slam/Puerto Pine moved more than 21,000 Army troops and 11,000 tons of their equipment to Puerto Rico on schedule but did not in some key respects realistically test the wartime airlift capability of Military Air Transport Service.

This conclusion was shared not only by MATS officers and air crews here, but also by industry representatives who were on hand in numbers to push new cargo plane concepts during the 15-day exercise, largest peacetime airlift in U S history.

Substantiation must await a MATS critique of Big Slam before the House Armed Service Subcommittee headed by Rep L Mendel Rivers (D-S C), which now is studying the adequacy of U S military airlift (AW Mar 28, p 38).

Inconclusive Test

Observers here pointed out that Big Slam/Puerto Pine, as opposed to a combat airlift, benefited from:

- **Almost two years of planning.** MATS budget requests for Big Slam, which cost about $10 million, were submitted in 1958. Prior to Mar 15, first operational day of the exercise, air crews received a 21-page brochure covering special Big Slam flying procedures plus departure plates (aircraft departure procedures) for staging bases and preferential routings to Puerto Rico.
- **Prepositioning of fuel** and spare parts inventories in Puerto Rico by sea-lift. Their absence at an overseas airlift destination probably would result in payload reductions and maintenance delays. Or, as in the Lebanon airlift of 1958, some transports would be flown as tankers to station fuel at turnaround point.
- **Preponderance of easily-loaded cargo.** The equipment accompanying Strategic Army Corps troops to Puerto Rico largely was selected to familiarize units with loading techniques. Many flights carried only wheeled vehicles. No ammunition crates were airlifted. STRAC commanders readily admitted that the force landed in Puerto Rico was neither "balanced" nor in a "tactical posture" when deployed.
- **Rarity of low ceiling, poor visibility weather.** Although airlift aircraft encountered some air mass and frontal thunderstorms en route to the Caribbean, weather conditions here were uniformly favorable to the operation and were so forecast.
- **Relative proximity of Puerto Rico** to Ft Campbell, Ky, home of the 101st Airborne Division, STRAC's lead unit, is about 1,740 statute miles from the island, well within the nonstop range of MATS' obsolescing aircraft. Charleston, S C, where preferential routings took airlift aircraft over water, is less than 1,300 statute miles from Puerto Rico.
- **Recuperation period** following Big Slam. Extra aircraft hours consumed by the exercise will not be added to MATS' yearly allocation of about five plane hours per day. Instead, about $7 million worth of commercial airlift will be purchased to fulfill MATS' global commitments. Most of these civilian flights are scheduled for April and May, giving MATS aircrew and maintenance personnel—most of whom worked 12-hr shifts seven days a week during the exercise—time to recover.

Almost certainly, MATS' final critique of Big Slam will underscore these and other advantages accruing because the airlift was staged between continental United States and Puerto Rico. That Big Slam was a hypothetical problem only applicable to other hypothetical problems with the same premises probably will be stressed.

Not to do so would leave unanswered the major question raised by the efficiency and precision with which the operation was conducted. Why, if MATS can accomplish this, does it need new aircraft?

To test whether the transport service truly can cope with the "hard core requirements" of limited or general war, as is claimed by Deputy Defense Secretary James H. Douglas, Secretary of the Army Wilber M. Brucker has proposed that a similar exercise be staged next year in Europe, the Far East or Alaska.

A point generally conceded by those concerned with Big Slam here is that the political and military climate for a firm allocation of funds with which to modernize the MATS fleet will never be more favorable. Not only does modernization have the backing of Rep Rivers and Sen A S Mike Monroney (D-Okla.), it also has won public declarations of support from numbers of previously uncommitted congressmen and from Army generals who watched the airlift in Puerto Rico.

On paper, Big Slam exercised MATS' ability to increase utilization of its 483 plane strategic airlift fleet from peacetime levels of 5 hr per aircraft per day to about 8 hr. This rate, according to the Air Force, would approximate wartime tempo.

The increased airlift generated by this worldwide "surge" was used to transport 78 STRAC units to Puerto Rico from 14 departure Air Force bases. While maintaining global commitments with one half of its strategic fleet, MATS assigned the other half to the Caribbean maneuver.

Troops deplaning from MATS transports at Ramey AFB and at Roosevelt Roads NAS—100 mi apart on the west and east coasts of Puerto Rico—were marched or trucked to nearby bivouacs and briefed on an airborne assault against a mythical aggressor. After spending two to four days on the ground, they were flown back to 29 home stations in the United States. Maximum troop concentration on a given day was about 5,300.

From Mar 17 through Mar 23, the airlift's peak period, the Douglas C-133s, C-124s and C-118s and Lockheed C-121s of MATS were landing or taking off at 3.75 min. intervals during Puerto Rico's daylight hours. All flights from the island were conducted under Instrument Flight Rules.

Flying Time Quotas

To sustain this pace, MATS raised monthly flight time quotas for its air crews from 125 hr to 150 hr. On-duty times for three-pilot crews were extended from 18 hr to 35 hr., after which a minimum stopover of 8 hr was required for rest. A group of five aircraft commanders at Roosevelt Roads told Aviation Week that most pilots in their squadrons would log the maximum of 150 hr before the end of the airlift.

Total ground time at Ramey was limited to 1 hr 30 min for C-118s, 2 hr for C-121s, 3 hr 30 min for C-124s and 4 hr for C-133s, in order to maintain flight schedules. Even less was allowed at Roosevelt Roads, where only C-124s and C-118s were off-loading cargo.

As the airlift unfolded smoothly here, top-level representatives of major airframe manufacturers—Lockheed, Douglas, Boeing, United Aircraft, McDonnell and Fairchild—were stressing the benefits of fleet modernization to ranking MATS officers.

A team from Douglas Aircraft Corp estimated that the cargo carried by the Big Slam/Puerto Pine aircraft of 222 transports, which flew 1,266 one-way sorties to Puerto Rico, also could be carried in 94 proposed Douglas planes flying 376 sorties. The freighter envisioned by Douglas, essentially an adaptation of its DC-8, would have turbofan engines and a payload capacity just short of 40 tons with range limited at 4,000 naut mi to 30 tons.

If about 100 were ordered, Douglas said the basic aircraft would sell for about $4.5 million without special cargo handling facilities required by the Air Force, such as a swing tail which would boost its price. The plane according to Douglas, could be delivered to MATS 23 months after contract go-ahead.

Lockheed Aircraft Corp., while not applying statistics directly to Big Slam, reported here that 64 of its Rolls Royce Tyne-powered GL 207-39 Super Hercules transports could account for 1.3 billion ton-miles of cargo in a year—about the same amount now carried by 200 MATS C-124s. Lockheed's computation was based upon a daily utilization rate of 5 hr.

Flyaway price of the CL 207-39, according to Lockheed, would range downward from $4.8 million per aircraft if 50 were ordered, to $3.6 million per aircraft if 145 were ordered. First deliveries would begin about 30 months from contract go-ahead.

In briefings, analysis of MATS fleet obsolescence received top priority. Repeatedly it was stressed that MATS had only 29 C-133s, with 30 more on order and due by mid-1962, representing the only "modern" transports in the service's inventory.

After a decade, the workhorse of MATS is still the C-124—291 of which are in service, representing a numerical 57% of the MATS fleet. But this aircraft which lacks transocean capability, is running short of engines and has a cruise speed of about 180 kt.

Air Force officers and industry representatives were hoping that the lessons distilled from Big Slam will clarify the question of how many and what types of aircraft should be purchased for MATS. These observers also hope that the Air Force will not be stampeded, as an aftermath of Big Slam, into placing a large order for an off-the-shelf transport that would be almost obsolescent by delivery date.

In one part of an eight year, $2 billion MATS re-equipment program presented to Congress, Lt Gen William H Tunner, MATS commander, has recommended the immediate purchase of 45 converted Boeing KC-135 tankers for "fast reaction" cargo service.

If funds for these aircraft were provided in the Fiscal 1961 budget, Gen Tunner estimates that deliveries could commence within 12 to 15 months.

But an opposition viewpoint, in currency here during Big Slam, holds that an adaptation of the KC-135, even though powered by turbofan engines, would not offer sufficient growth potential to MATS to warrant purchase. Proponents of this view maintained that the group of congressmen, Department of Defense officials and Air Force officers—in whose hands, they said, the purchasing decision now rests—should be willing to accept a time penalty of at least one year to gain a more advanced freighter.

The objective that Army, particularly STRAC, seeks to attain from Big Slam critiques appears to be a more precise definition of the airlift priority it would be accorded at the outset of brushfire war. STRAC officers here point out that the corps leading company, always on 15 min alert, could reach a staging airport before the first planes arrived to airlift it overseas.

They emphasize, however, that under present planning only STRAC's lead division—the 101st Airborne—would be moved by air to a combat zone. While the airlift of the 101st would take six days, the 4th Infantry Division, moving by sealift, would not close with the aggressor for 26 days. And the 82nd Airborne Division, also traveling by sea, would be five days further behind.

Thus the shortage of airlift would dilute the effectiveness of STRAC's three division force, maintains the Army.

A further complication envisioned by the Army is that much of MATS airlift capability during a national emergency would be held in reserve to support the Strategic Air Command, should it be summoned to action. For this reason Army is not sure how much airlift support it actually can count upon.

To these contentions, the Air Force points out that on Big Slam/Puerto Pine more than 90,000 troops without equipment could have been airlifted. This indicates to the Air Force that the Army should place renewed emphasis upon pre-stocked forward depots to reduce the tonnage carried by strategic airlift. Instead of trying to combine mass and mobility, which results in an astronomic airlift requirement, the Army should concentrate on mobility and move the mass ahead by surface transportation media.

In addition, the Air Force says, the 232 aircraft now in the Civil Reserve Air Fleet—which played no part in Big Slam—would supplement the airlift force available in war emergency.

Big Slam/Puerto Pine Data

Total trips to Puerto Rico	2,516
Total tons transported	10,925
Total aircraft hours flown	24,290.2
Army troops airlifted	21,002
Schedule reliability	
Outbound	95.3%
Inbound	92.5%
Over-all	93.9%
Average turnaround time	
Ramey AFB	
C-118s & C-121s	2.1 hr
C-124s	2.7 hr
C-133s	3.4 hr
Roosevelt Roads	
C-118s	1.1 hr
Minimum ground time	
C-118	24 min

Aeroflot Says Pilots Caught Red Handed

Moscow—Pilots for Aeroflot, Russia's state-owned airline, who belong to one of the best paid professions in what the Soviets term their "classless" society, have been caught trying to make a dishonest ruble.

Reports of Aeroflot flight personnel capitalizing on their positions for personal profit came recently from two of the carrier's subdivisions. Worst offender among those caught red-handed has been removed from flying duty, but only after top Aeroflot brass stepped into the hushed-up case.

Sovetskaya Aviatsiya, Soviet air force newspaper, called attention to the scandalous activities of Li-2 Capt V. Stoyanov in a story headlined "Speculator in an Airplane." Stoyanov, it seems, began his career in crime by transporting several boxes of apples from sunny Frunze in Soviet Central Asia to the Urals' industrial center of Sverdlovsk, where he sold the fruit at "speculative prices."

Even worse, according to Sovetskaya Aviatsiya, all the members of Stoyanov's crew, members of the local Communist Party bureau and the Aeroflot subdivision commander knew what had happened but did nothing about it.

Later, when large numbers of apples ripened in the Frunze orchard of Stoyanov's mother-in-law, the Aeroflot pilot decided to make a killing on the black market. Stoyanov persuaded his group commander to let him make a trip to Akmolinsk.

Stoyanov then proceeded to replace some of the high priority cargo with two tons of apples put his wife aboard the plane to keep an eye on the fruit and flew to Akmolinsk.

Since the apples failed to sell rapidly in Akmolinsk, the Li-2 remained there for several days.

When the subdivision commander in Frunze inquired as to the plane's delay, Stoyanov reported mechanical difficulties. Next day, the Stoyanov Li-2 headed for Chelyabinsk, where he sold the apples and went on a spree with his flight mechanic. The pilot's resulting hangover delayed the plane's departure for Frunze and led to the discovery of Stoyanov's illegal operations.

Sovetskaya Aviatsiya said Aeroflot's Frunze group commander attempted to cover up the operation and only gave Stoyanov and his mechanic a reprimand for "violating preflight rest regulations."

Earlier this year, the Soviet newspaper Komsomolskaya Pravda reported how An-2 pilots on the Baikal Irkutsk run in Siberia speculate in fish. The article said An-2 crews sometimes keep their planes and passengers waiting at Baikal for hours while they search for fresh salmon for sale at Irkutsk.

LOWEST JET AGE OPERATING COSTS

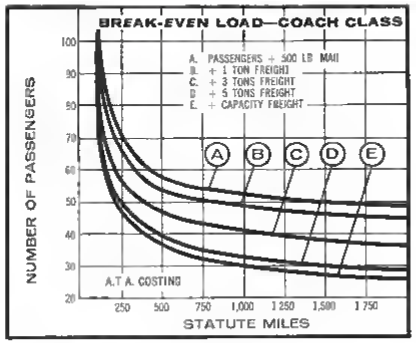
135 passengers . . . 8 tons of freight . . . 425 mph . . . 2,300-mile range

No other jet age airliner—pure jet or jet-prop—can match Vanguard's economy of operation. Seat-mile costs can be *under 1¢* on all stages over 1,000 miles; and only 1.4 cents at 200 miles.

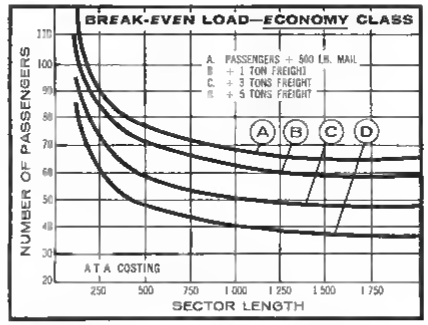
"Passenger only" break-even loads are 61 first class or 68 coach class on a 250-mile sector, and as low as 46 and 52 passengers respectively at 1,000 miles. This is *without* freight revenue. With 3 tons of freight, only 55 coach passengers are needed to break even at 250 miles, and 40 at 1,000 miles. Vanguard's below-deck cargo holds enable the aircraft to be a profit-maker on off-peak services and in off-peak seasons.

Low altitude routing will not adversely affect these low costs. The difference in trip cost between a 500-mile sector flown at 10,000 feet and 20,000 feet (most economical) is only $44.

Vanguard's low operating costs and large, well-balanced payload capacity of 29,000 pounds mean the *highest profit potential in airline history!*



This graph emphasizes the Vanguard's considerable cargo carrying capacity. When freight is carried, the economic flexibility of the aircraft is underlined. With freight the passenger need comes down to as low as 47 passengers on a 250 m.le stage and 30 for 1,000 miles.



The "economy" class gramme-goal fare potentialities of the 139 seat Vanguard are shown by these curves which give the break-even needs on all costs (indirect costs taken as 100% of direct) at a fare rate all only 4 cents a mile. This is a 25% reduction in existing coach fares. Freight revenue is taken as 21.8 cents a ton mile. ins I as 34.7 cents and egress as 34.3 cents.

As a result, Vanguard makes the introduction of promotional fares and other traffic-builders not only possible—but highly *profitable*.

TOPS IN PASSENGER APPEAL TOO!

Inside the comfortable cabin, Vanguard will be as quiet as the Viscount. Vanguard block speeds have been proved as fast as jets right up to medium-distance sectors, though Vanguard has been flown at less than half jet costs! And, due to the absence of ATC approach, stacking and noise problems, there won't be as many delays in high-traffic areas.

For further details and a cost analysis based on your operations, contact Christopher Clarkson, U.S. representative, 10 Rockefeller Plaza, New York 20, N. Y.

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Vanguard benefits greatly from the more than 2 million hours of worldwide in-the-air experience of 400 Viscounts . . . and there is *no* substitute for experience!

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POWERED BY FOUR ROLLS-ROYCE TYNE ENGINES

VICKERS
VANGUARD

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AIRLINE OBSERVER

► Strong differences between the chiefs of the Federal Aviation Agency and Civil Aeronautics Board on safety rulemaking and accident investigation authority recently came to a head in separate testimonies before the House Appropriations Subcommittee. In his testimony, Board Chairman James Durfee admitted he believed a split authority between the two agencies existed and reiterated his opposition to the transfer of safety rulemaking authority from the Board to the FAA in 1958. Later FAA Administrator E. R. Quesada said it was his "personal feeling" that accident investigation should now be transferred to FAA from CAB, contending that the Board should have jurisdiction in economic matters, FAA in safety promotion.

► Snd Aviation officials are hoping Soviet Premier Khrushchev wasn't joking last week when he said he would order 12 Caravelle turbojet transports following a trip on the aircraft during his tour of France. Snd headquarters expressed little hope that Khrushchev would follow up his remark but one official noted that, while in the U. S., he took a liking to the Sikorsky S-58 helicopter, later ordered two (AW Oct. 5, p. 25; Mar. 14, p. 37).

► Six East European Airlines, in an apparent move to match West Europe's Air Union, have completed a two-week conference in Warsaw designed to bring about closer cooperation between six flag carriers representing Soviet satellite nations. Every phase of airline operation, including costs, equipment, operating techniques and planning, were discussed. The six carriers are East Germany's Deutsche Lufthansa, Czechoslovakia's CSA, Hungary's Malev, Bulgaria's Tabso, Rumania's Taron and Poland's LOT.

► Iberia Air Lines of Spain has completed its financing for the purchase of three Douglas DC-8 turbojet transports at a cost of $20.6 million for delivery in early 1961. Planes will be powered by Pratt & Whitney JT3D turbofan engines. Export-Import Bank of Washington will finance 68%, or $14.1 million, of the loan. Douglas will finance 12%, $2.4 million, with Iberia covering the remaining 20%, or $4.1 million.

► Russia already is making good on its promise that 1960 will see a spectacular expansion of helicopter operations within the Soviet Union. During February, Aeroflot reports that it inaugurated its first inter-republic helicopter line with single-rotor Mi-4s. The new route links Frunze, capital of the Kirgiz Soviet Socialist Republic, with the rail junction of Lugovaya in Kazakhstan. Aeroflot this month also plans to begin regular helicopter service between three districts within the city of Kiev and from Lvov to two nearby resorts. In the Crimea, Russia plans to use 40 helicopters for vineyard dusting operations. Scheduled helicopter service also has been inaugurated close to the Arctic Circle with inauguration of flights between Archangel and Severodvinsk. Ten-passenger Mi-4s make the 37-mi. run four times daily.

► Caribbean-Atlantic Airlines—Caribair—is considering inauguration of helicopter service between San Juan, Puerto Rico, and nearby islands lacking air terminal facilities. Seat-mile costs of various helicopters and traffic demand on routes to Vieques Island, just off the Puerto Rican coast, and to St. John, an island in the Virgin Islands 80 mi. east of San Juan, are now being studied by the airline. Last month, Caribair President Dionisio Trigo visited Boeing's Vertol Division plant in Morton, Pa., for a demonstration flight in the twin-turbine Vertol 107.

► Lockheed Aircraft Corp. reports that its proposed GL-207-39 Super Hercules transport powered by Rolls-Royce Tyne turboprop engines (AW Mar. 28, p. 38) can take off with a ground roll of 730 ft. and a payload of 25,000 lb. on Air Force STOL missions of up to 1,500 naut. mi. At maximum gross weight of 230,000 lb., a payload of 77,000 lb. and with its engines developing 6,445 eshp. at takeoff, the aircraft would break ground at 4,080 ft. and operate at a range of 3,020 naut. mi.

► Philippines will resume discussions with the U.S. on a bilateral transport agreement sometime after Apr. 11. Original agreement expired Mar. 3.

SHORTLINES

► Aer Lingus pilots' strike was scheduled to end last week. Irish Air Lines Pilots' Assn. and Aer Lingus management have agreed to accept the Eire Labor Court's recommendations concerning the future of six pilots whose suspension for alleged violation of the company's rules concerning alcoholic drinks provoked the strike. Recommendations were not disclosed.

► Air Traffic Conference of the Air Transport Assn. and American Cable & Radio System have entered into an agreement whereby holders of ATC Air Travel Cards may use the cards when sending international radiograms and cablegrams over ACR's system.

► Boeing Airplane Co. has delivered the 100th transport in the 707 series. Delivery was made to Air France.

► Capital Airlines and Delta Air Lines have added passenger self-ticketing services to their systems. Under the plan, passengers make advance reservations and then write their own tickets which are supplied by the airlines. Originating city, destination, flight number and date are written onto the ticket by the passenger.

► Civil Aeronautics Board hearing examiner has recommended the foreign air carrier permit of Aerovias Ecuatorianas, C. A., be revoked since the government of Ecuador has canceled the airline's authorization to operate to the U. S. Under the bilateral agreement between the two countries, Aerovias Ecuatorianas was authorized to operate between points in Ecuador to Panama City and Miami. However, it has not conducted operations on the route for the past several years.

► Communist China officials report that their state-owned civil airlines flew over 30% more ton-miles in 1959 than in 1958. Domestic route mileage totaled almost 22,977 mi. The Chinese also report that they plan to open new international service to Ceylon.

► Delta Air Lines has received Civil Aeronautics Board permission to extend its service suspension to Ciudad Trujillo, Dominican Republic for an additional year. Delta's permission to suspend service to the Caribbean country received last year was to have expired on Apr. 1.

► Trans World Airline pilots have created a foundation in memory of Jack Fry, former past president of TWA. Foundation will provide technical reference books to various leading aeronautical engineering universities.

FOUR-STAGE Javelin launching vehicle undergoes final assembly at National Aeronautics and Space Administration's Wallops Station in Virginia. Fourth stage of this vehicle is an X248 rocket, developed as the third stage of NASA's Delta launching vehicle

NASA Expands Wallops for Space Role

By Craig Lewis

Wallops Island, Va.—National Aeronautics and Space Administration is rapidly expanding Wallops Station beyond its traditional high-speed flight research function to serve as a space vehicle test and launch facility.

Wallops Station is in the midst of a $16 million expansion program that will bring the total investment here to $24 million when the work is complete. Construction work is in the final stages and should be finished by summer. Instrumentation programs are about half way to completion.

This major expansion of the Wallops facility will equip it to cope with the increasing speed, range and altitude of the rocket vehicles launched here in research programs. It also will give Wallops Station the means to do a more efficient job in such component test programs as the Little Joe phase of Project Mercury.

Along with these research and development functions, Wallops will be equipped as an operational launching base for sounding rockets and small earth satellites.

NASA has launched a substantial growth program since it took this facility over from its predecessor, the National Advisory Committee for Aeronautics, 18 months ago. Wallops had been operated since 1945 as a flight test station for rocket-launched research models used to explore flight characteristics in the higher speed ranges. Starting with investigations of aircraft flight problems in the transonic and low supersonic area, research has progressed to the point where it is now almost entirely concerned with hypersonic and space flight research.

In this period speed capabilities of research vehicles have advanced from about Mach 1 to the Mach 24 region. Altitudes have kept pace, and last year a Strongarm rocket launched for the Army reached an altitude of 1,050 mi. Thus far, Wallops has fired more than 3,000 research models.

New Facilities

Wallops Station has acquired new property as well as facilities to meet increased demands. Work area was formerly confined to the NACA Pilotless Aircraft Research Station on Wallops Island, which was run by Langley Research Center. Last July, the Navy transferred its Chincoteague Naval Air Station facilities to NASA, and facilities on the island and at the air station nearby on the mainland have been combined into Wallops Station, which is now a separate entity in the NASA organization.

Under the expansion program, facilities on the island are basically oriented to launch functions. Administrative, technical, range control and some instrumentation functions are being concentrated on the mainland. A new causeway has been built to connect island and mainland facilities and eliminate the time-consuming ferry trip formerly required. Currently, Wallops has 105 employes on the island and 120 on the mainland, about a third of them technical.

On Wallops Island two new launch pads, a blockhouse and other facilities are nearing completion at the north end of the launching complex. One of these pads has a gantry for the Scout solid propellant launch vehicle. This rocket is designed as an inexpensive launch vehicle and will be used as a vertical probe and to launch small scientific satellites. Originally scheduled to be tested late last year, Scout is now to be fired for the first time by summer.

On the other side of the blockhouse from the Scout tower is a pad which will be adaptable to various launchers and will be available to such vehicles as Little Joe and the NASA six-stage re-entry test rocket. This launch complex, plus facilities for an Aerobee launcher, cost $2 million.

The original Wallops launch pad area will be used for aerodynamic probes, and sounding rocket launches will be made in the area adjacent to the new $900,000 Aerobee launcher. This Aerobee tower is similar to the facility at Ft. Churchill, Canada, but it has four rails instead of three and consequently can be used for four-finned rockets. The tower can be adjusted for launch angles between 75 and 90 deg. and it will handle rockets 10-20 in. in diameter. NASA now can fire Aerobee, Aerobee Hi, Spacrobee and Super Aerobee rockets as well as later solid rocket developments in this Aerojet-General sounding rocket family.

Use of Aerobee with its acid and aniline propellants introduces new liquid propellant handling problems to a facility which previously used only solid propellant rockets, but R. L. Krieger, chief of Wallops Station, foresees no special difficulties. Aerobee was included in the Wallops complex because the Naval Research Laboratory group which was absorbed by NASA has had considerable experience with this family of rockets. First launch was made from the Aerobee tower in February, but launch failed because of a malfunction in the second stage.

Expansion program also includes a destruct system transmitter facility on the south end of the island complex. As launch operations increase in scope, the destruct system has to be expanded and improved. Range safety officer will control the system from a new mainland control center.

Tracking Capabilities

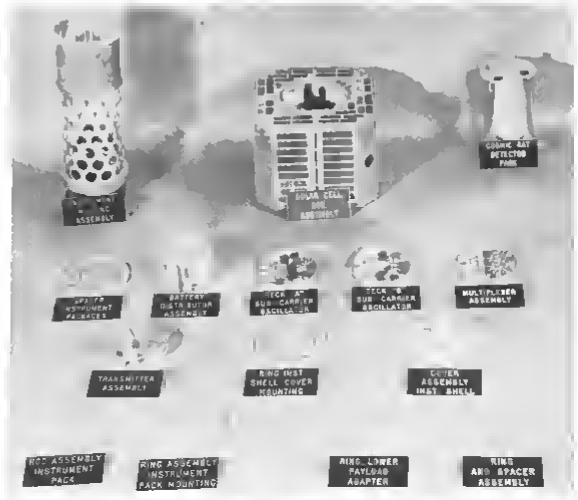
Tracking capabilities are being expanded to keep pace with launch operations. Two new tracking radars with 60-ft. antennas are being installed on the mainland near Wallops Island. This FPS-6 long range S-band radar will determine position and velocity, discriminate between objects and detect scintillation, all simultaneously. One of the two 60-ft. radars will be used by NASA, and the second, which is now operational, is being used in a state-of-the-art tracking program by Lincoln Laboratory of Massachusetts Institute of Technology.

On the island NASA has an FPS-16 radar which provides better tracking accuracy, digital output and other improvements over older radars. In the same complex, there is a modified SCR-584, which is especially useful because its wide antenna pattern provides relatively easy acquisition, and an AMFTC Mod. 2 radar, which is a substantial modification of an SCR-584 done by Reeves Instrument Corp. This Reeves system has a tunable transmitter tube which permits frequency changes to avoid interference, and its two-channel receiver permits easy switching between beacon and skin tracking.

As programs expand in scope, Wallops Station is doing more work with other agencies in coordinating efforts like the suborbital tests of the 100-ft. inflatable sphere for Project Echo. This requires increased telephone communications capability and the communications center adjacent to the island radar site has been expanded to handle the load.

Wallops Station also is in the midst of a substantial modification of its telemetry system to accommodate the increased ranges and types of rocket

SCOUT ROCKET LAUNCH TOWER (left) was built by National Aeronautics and Space Administration at Wallops Station to give the facility satellite launching capability. Long-range FPS-16 radar (right) is used to track research missiles at the Wallops Pilotless Aircraft Research Station. Antenna dish is mounted on two-story concrete building which contains its control elements.



Explorer Satellite Payload Package Detailed

Breakdown of the instrument package for the complex Explorer satellite for radiation measurement is detailed above. Satellite was prevented from entering a highly elliptical orbit when an upper stage of Juno II launch vehicle failed (AW Mar. 28, p. 30). In orbit, the casing of the fourth stage (Sergeant) would have remained attached to the satellite to serve as an antenna for transmitting data. The Explorer carried five cosmic ray detectors in a single pack (top right) to count electrons at varying electron volt ranges and to measure particle absorption and penetration. Total weight of the satellite in orbit would have been 35.3 lb. Satellite contained 1,184 solar cells.

systems coming into use. Wallops has been using a telemetry system developed here at the station to meet its particular needs. With the advent of sounding rocket and satellite activity, the station is getting commercial standard FM/FM telemetry, and pulse width modulation telemetry equipment will be installed for sounding rocket use.

A new telemetry facility will be built at the headquarters area on the main land, and it will be equipped with a new high gain receiving antenna. This facility is part of the program for building up the former air station to accommodate administrative range control and technical support functions.

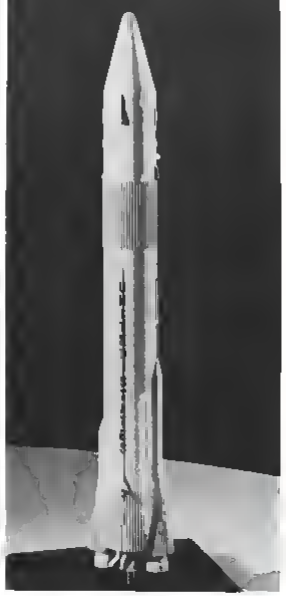
Range Control Center

Range control center is part of this program. It will be linked to the island launch sites and will have analog radar data display and a closed circuit television system to present the information needed by the range control and range safety officers. Tracking and data acquisition network will have digital data recording capability, and the main land facility will have a digital computer installation.

Wallops programing and timing capability is being expanded, and other improvements included in the modernization program are operations intercom, communication, pad warning, wind measuring and paging and countdown systems. Station will also get a GMD-2 weather balloon tracker and a long focal length tracking telescope. Hangars at the mainland facility are being modified to accommodate storage and assembly of rocket vehicles.

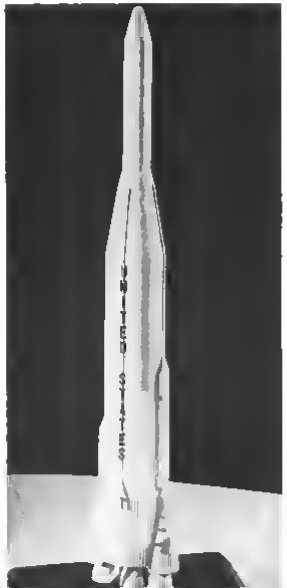
These elements of the current expansion program have already been funded in the NASA budget. The Fiscal 1961 budget NASA is now presenting to Congress includes money for a precision tracking system, an operations computing center and improvement of some existing support equipment at Wallops Station.

Wallops Station has a supersonic blowdown tunnel on the island which has been in use since 1948, but its research role is currently declining. NASA also has a shock tube facility on the island for studying the effect of loads from blast-induced gusts on aircraft. The shock tube is 80 ft. long and 10 ft. in diameter. Frangible diaphragm is used to trigger a high density Mach 1 flow, and an explosion is set off to study effects while the air is flowing over a fixed model.



NASA Plans Keyed to Limited Booster Family

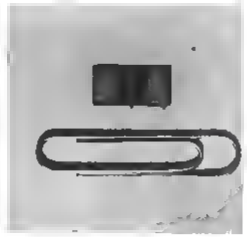
Scout solid propellant vehicle (not shown) and the Thor, Atlas, and Saturn will be the four workhorses of National Aeronautics and Space Administration's space program. Top left is Thor Agena B. Top right is Atlas Centaur. Bottom left is Atlas Agena B, and bottom right is one configuration of Saturn, which uses hydrogen-fueled upper stages.



Westinghouse presents working proof of the principle of molecular electronics

POWER AMPLIFIER: Button-sized molecular electronic device held by gul with a pair of tweezers performs the same amplifying function as a conventional 5-watt amplifier, has a frequency range from zero to 20,000 cycles. Working element is a block about as large as the head of a pin.

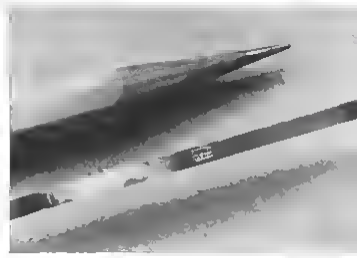
VIDEO AMPLIFIER: made with a tiny wafer from a ribbon of germanium crystal. This function block also works like a radar amplifier sub-system. Gain is essentially flat to frequencies of several megacycles.



MULTIVIBRATORS. bistable, monostable, and astable—covering frequencies from 1 cycle or less to 3 megacycles. Shown is a free running multivibrator alongside paper clip.

D-C AMPLIFIER: connected to a solar cell, this tiny block takes an input of 4 milliamps . . . via flashlight beam, raises it to 40-watt output

CRYSTAL GROWING techniques developed by Westinghouse have already produced germanium dendrites 300 feet long in the special furnace shown at left, above Crystal ribbons of almost any length are possible The take-up reel at right holds 300 feet of the brittle dendrite with each turn cushioned on glass-cloth tape.



CRYSTAL RIBBON requires no grinding or lapping. Only a few steps are needed to turn these "educated" crystals into working electronic systems Above, multiple-junction systems are shown on a crystal section.

MULTI-POSITION SWITCHES: these molecular electronic devices evolved out of Westinghouse work on multivibrators—the "OR" logic switch illustrated has important potential applications in missile countdown functions.

LIGHT TELEMETRY SUB-SYSTEM: a single light-responsive monolithic element delivers output whose frequency is a measure of light intensity.

The meaning of molecular electronics

RELIABILITY: molecular systems reduce drastically the number of components and internal connections required—and the fewer components and connections the fewer potential trouble spots.

MINIATURIZATION: molecular electronic systems are less than one-thousandth the volume and weight of conventional component systems This is a conservative generalization—in many cases, much more startling size and weight reductions are possible.

POWER REQUIREMENTS: input power can drop almost as fantastically as size and weight. In a typical light telemetering sub-system, a 5-watt input is required, the transistorized version gets by with 0 75 watts The same function is still performed by a molecular electronic block requiring but 0 06 watts

ENVIRONMENT: inherently more resistant to g-loads because of their small mass and few components, Westinghouse-developed molecular systems show promise to be temperature and radiation resistant as well. New semiconductor materials and new large crystal surfaces point to very high temperature and power-handling capabilities.

FUTURE: progress in this new field is so rapid, and the advantages so great, that the molecular electronics concept will find wide applications in air/space electronic systems within 3-5 years . . . In particular, look for great advances in the state of the art in these areas: telemetering • fire control guidance • communications • counter weapons • flight control—as a direct result of the new molecular electronics era.

The Air Arm Division of Westinghouse Electric Corporation holds the U. S. Air Force management contract for this project It is being supported by the Semiconductor Department, the Materials Engineering Department, and the Westinghouse Research Laboratories.

J-92311-1-3

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Missile Support Becomes Prime Cost Item

By Michael Yaffee

Detroit, Mich.—Cost of missile support appears to be going up but the increase is mostly a matter of paper work and definition rather than of actual higher price tags on support equipment. Peter B. Weiser of Space Technology Laboratories told the American Rocket Society ground support equipment conference here.

Currently the cost of operational ICBM squadrons (nine single-shot launchers, 10 missiles) are expected to run from $130 to $170 million depending upon the degree of hardness and dispersion. Missile cost, which will be essentially constant, will account for approximately 10 to 15% of this or $17.19 million. The rest of the cost, roughly $111 to $153 million, goes for the missile support systems.

Only three years ago technicians were estimating the cost of operational missile squadrons at $70.90 million and allocating only about $51 to $73 million to the cost of support systems. In going over these estimates, Weiser and others found them to be optimistic. Basically these early estimates took into account only the actual ground support hardware and overlooked such non-hardware costs as personnel training, printing and distribution of manuals, and maintenance. Equipment such as the Jeep-type vehicles necessary to transport site personnel were not included.

Weapon System

Weiser breaks down the complete weapon system as follows:

- **Missile** consists of the airframe, propulsion system, guidance and re-entry vehicle—or all systems, subsystems and components that actually fly.
- **Ground operating equipment** is the munitions equipment required to launch the missile, including launch control equipment, launch consoles, electrical equipment and various cabling devices, elevation equipment, water or other required utilities and the propellant loading system.
- **Ground support equipment** is all other equipment in the squadron—the equipment required to test, maintain, handle and repair the missile but not required in the actual launching of it. This covers checkout equipment, missile handling trailers, cranes, propellant tanks, tankers, component test equipment and handling equipment.
- **Training**. This involves first the determination of number and types of personnel required to man an operational site. After this comes training of the individual airman at contractors' plants or at the various Air Training Command bases, then integrated weapon system training at a different base such as Vandenberg AFB. This entails training the operational and maintenance teams that will make up the squadron, followed by on-the-job training at the operational site which may involve the integration of new personnel into the squadron and continuing proficiency training of the teams, probably using simulation.
- **Manuals**. Training requires a manual program so extensive that an electronic data processing method is needed just to control scheduling of manuals. A multitude of manuals, says Weiser, has to be prepared for personnel and on equipment. These manuals have to be written, edited, printed, distributed, and updated. They must be ready to meet

Minuteman Test Silo Built at Cape Canaveral

Sandy soil and high water table level require unique system of construction of Minuteman ICBM test silos in Complex 31 at Cape Canaveral, Fla. Two cylindrical wood shells comprising inner and outer pouring forms are positioned about 18 ft. above ground, reinforcing concrete rods are inserted, and concrete is poured. Concrete is allowed to harden and soil is then dug out from center of concrete cylinder permitting the concrete silo section to slide down into the sand. When the top of the hardened concrete silo section is at ground level, forms for a new section are moved into place on top of the completed section and process is repeated. Building under construction in front of Minuteman silo is for launch monitoring equipment. When completed the roof will be below ground level. Building will be unmanned and used only for Minuteman test installations, not for operational silo sites.

What you should know about Analog Computers

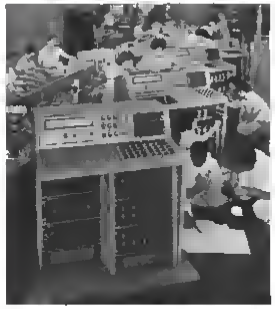
Judging from the literature, most discussion of analog computers turns on form rather than function.

Every computer manufacturer, including Donner, is ready to tell you all about their designs, right down to the last microvolt. Few spend their literary effort in telling you how to use them and what kind of problems are amenable to analog computer solution. Not too strangely, this is what you, the prospective user, wanted to find out in the first place.

The Donner 3400 Desktop Computer functions as a compact, versatile electrical model of a dynamic system.

HOW AN ELECTRONIC ANALOG COMPUTER SOLVES PROBLEMS

A mathematical expression which defines the dynamic behavior of a particular physical system also describes the behavior of all other analogous systems. A general purpose analog computer can be programmed to behave as one of these analogous systems. So programmed, it can be used to explore the characteristics of the system or to "solve" the describing equations. Typical problems range all the way from explaining the laws of classical and modern physics to the physiological relations of life itself. Here are some of the fields where analog computers are in use: antenna design, medical research, cybernetics, electron trajectories, nuclear reactor design, fluid mechanics, heat transfer analysis, aerodynamics, meteorology, classical and nuclear physics, chemical kinetics, petroleum, engineering, servo system analysis, auto- and cross-correlation, and economic forecasting.



Assembly of Donner 3100 series high accuracy medium size analog computers in quantity lots provides the user with more value at lower cost. Complete Donner 3100 Computer Consoles start at just under $11,000.

Basic computing elements in an electronic analog computer are dc amplifiers, precision components (resistors, capacitors, and potentiometers), and non-linear accessories (multipliers, function generators, and transport delay simulators).

By interconnecting the computing elements at a patchboard, varying voltage amplitudes can be integrated, summed, differentiated, multiplied, divided, altered in non-linear fashion, and otherwise operated on as directed by a mathematical equation. The answer, which appears as a varying voltage, can be visually observed on a voltmeter or an oscilloscope and permanently recorded by any one of several plotting devices.

The analog computer user can take an equation, change the coefficients at will, and get whole sets of solutions with amazing ease and speed. He can get these results to accuracies of 0.1% or better for a very modest investment. Small Donner computers begin at just over $1,000.

ANALOG OR DIGITAL

The chief advantages of the analog technique are speed, economy, and flexibility. With the analog computer, you get a genuine insight into the response of the system to both internal and external stimuli. No other approach can bring the investigator into such intimate contact with the system.

Digital computers sometimes provide more accurate results, but they seldom give the user the same knowledge because they are at best only machines that compound arithmetic information. Unlike digital computers, analog computers actually behave just like the simulated systems.

TWO NEW PUBLICATIONS PROVIDE MORE INFORMATION

If you are interested in learning more about the application of analog computers, copies of Donner Tech Notes #1 and #2 are available from your nearby Donner engineering representative or directly from the factory. Tech Note #1 is titled "How to Simulate a Non-Linear Control System with an Analog Computer," Tech Note #2, "How to Use and Program Analog Computers."

Donner Scientific specializes in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control dynamic inputs. Complete technical information and informed applications assistance can be obtained from your nearby Donner engineering representative or writing Dept. 09.

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the men at training sites and at the operational sites and also be ready to go along with the equipment for which they were prepared.

Personnel training involves other problems and costs as well. Highly trained missile men, particularly the non-commissioned officers, get and often take attractive offers from industry causing high and costly personnel turnover. Morale is another factor; how long can a man be kept ready at an operational site? Proficiency is even more of a problem. Missiles cannot be launched from operational sites in peacetime due to the flyover problem (dangers involved in launching over populated areas). Discrepancies can be put into missiles for maintenance personnel to find and for the operational personnel to overcome says Weiser, but this could be dangerous in operational missiles if someone forgot to correct these discrepancies or couldn't remove them in time.

Some type of new and probably costly simulator would be desirable.

Maintenance also means a major overhaul in Air Force thinking. Up to now, for example, Strategic Air Command has been primarily an operator. Now, with missiles spending 99.9999% of their life on the ground, SAC feels it will have to become a maintainer. Moreover, established Air Force maintenance policies will have to be overhauled. Weiser points out that one policy—do as much maintenance as far ahead as possible—would mean that the entire launcher establishment would have to be very large (and expensive), with space for working and environmental controls, added space for spares and personnel, and added handling equipment.

System Supplies

Other support system activities cited by Weiser include the following:

• **Logistics.** The supply and resupply of all squadron requirements, has necessitated the establishment of a complicated electronic data processing system that automatically inventories stock levels for all squadrons and automatically dispatches orders to contractors when supply of any given part falls below a specified warning level. Many persons are required to establish this system, Weiser said, and many more are required to maintain it. Also involved is the cost of the electronic equipment itself and the cost and time concerned with revising the system whenever design concepts change.

• **Facilities.** Divided by Weiser into operational facilities and support facilities. Operational facilities are those that protect the missile from the environment and aid in its launching including such things as the launch operations building, the bunker that erects a

vehicle the silo with its elevator. The support facilities include roads, security fencing, munitions buildings and all of the maintenance area back at the base.

• **Communications** must be highly reliable, well protected, redundant and, consequently, costly. There may be two to four different communications systems, ranging from public address systems to microwave, connecting any two points in a squadron. Moreover, there must be direct communication between the squadrons and SAC headquarters, between SAC and Washington, D. C., and between Continental Air Command and all such areas.

• **System management,** which Weiser considers as important as any other phase of the weapon system, consists essentially of direction and control of costs, schedules and reliability in the development and operation of an effective weapon system.

Checkout Underestimated

When it came to setting up operational sites, additional problems and expense items came to the fore, the full extent of which were not or could not be discerned beforehand. One cost in particular, that of the installation and checkout involved in actually putting a weapon system in the field, was greatly underestimated.

In the big ballistic missile systems, the concurrency concept added its own problems and costs. This concept, which calls for the design and development of system support equipment and facilities in parallel with that of the missile, means that engineers are designing at best for an unproven element and at worst for an unknown element. They may, for example, have to design and build a blockhouse before the quantity or configuration of the equipment that will have to go into it is known. Right now the Air Force is building operational sites for the Atlas-E series of missiles when none of these missiles has yet been flown. So far concurrency costs have been kept to a minimum but there is no guarantee that this will continue to be the case.

Telescoping Time

The continuing attempt to telescope time also adds to system support costs in other ways. In order to maintain missile squadrons at as close to 100% readiness as possible, for example, the Air Force uses a fast propellant loading system that enables a missile such as the Thor to get into the air within 19 min. The cost of this propellant loading system is approximately $10 million per squadron. The Air Force is now evaluating a promising system for keeping liquid oxygen on board the missile. This system may cut the countdown time in half and eliminate the $10 million cost of the other system, but no one is sure that even if the new system proves out, that it can be ready in time to be put into any operational sites.

Although aimed primarily at operational liquid propellant ballistic missile weapon systems, these system support definitions and cost breakdowns are expected to prove applicable with only minor modifications to operational solid propellant missile squadrons as well.

At an operational solid propellant missile site, there will be more missiles but they will probably be less expensive. Control centers will be more expensive, but the underground launching silos—still with no refire capability—will probably prove to be less expensive than their liquid propellant counterparts. The ratio of missile cost to overall system cost, according to Weiser, will probably work out to the same 10 to 15%.

Maj. Gen. Ben I. Funk, commander of the San Bernardino Air Materiel Area, Norton AFB, disagrees to some degree with Weiser on system support costs for solid propellant missile systems.

There is evidence, Gen. Funk said, that in second generation ballistic missiles such as the Minuteman that cost of ground equipment will be a much smaller part of the total weapon system cost. The use of solid propellants and other advances he said eliminate the requirement for a large portion of ground operating equipment.

No longer is there a requirement for, example, for expensive air conditioning and climatic control, which was a basic requirement in radio inertial guidance systems. Moreover, he said there is no requirement for propellant loading and cryogenic distribution systems or for large capacity on-site generated power and water pumping and distribution systems.

Weiser told AVIATION WEEK that there is an analogy between space vehicle and the research and development launching phase of ballistic missiles at Cape Canaveral, Fla. The facilities required for the present generation of space vehicles are very similar to or the same as those used to launch research and development ballistic missiles. There is no need for instant readiness, for as great automaticity, or for as many technicians. There, is however a greater requirement for data collecting systems. Few launching sites will be required but these will have to have refire capability for repeated launchings. Also, space vehicle and research and development launching facilities are physically larger than operational missile launching equipment.

New facilities will have to be built for the second generation space vehicle,

French Fire CT-41 Target Missile

Nord Aviation's CT-41 ramjet-powered target missile is launched at the French missile test center, Colomb Bechar, Algeria. Recoverable target vehicle (AW Feb. 29, p. 65) is boosted by two solid-propellant engines and can attain Mach 2.5 powered by twin ramjet sustainer engines. Launcher's supporting arms swing clear of the missile at liftoff. Bell Aircraft Corp. has an option for U.S. manufacturing rights to the CT-41.

Weiser said. These will have to accommodate the handling and support of high energy hydrogen fuels, nuclear propulsion systems, and the like. Ultimately, manned space and planetary stations will come, with their greatly magnified facilities problems and costs.

A comparison of space vehicles to operational weapon systems shows a definite difference in the ratio of vehicle costs to support systems costs, Weiser said. In space systems there will be considerably fewer and considerably more expensive vehicles (payloads included), there will be only a few launching sites and support systems costs will be significantly less with the major exception of data collecting, transmission and handling equipment.

Additional details on space vehicle systems and their support requirements was provided at the ARS meeting by Dr. Homer J. Stewart, director of National Aeronautics and Space Administration's Office of Program Planning and Evaluation. Perhaps the most important consideration in this area, as underlined by Dr. Stewart, is the fact that overall spending on space vehicle systems is going up significantly. Three years ago, the United States was spending only about $25 million a year on space activities.

NASA's latest proposal calls for an annual budget of $900 million.

In general, Dr. Stewart goes along with Weiser's conclusions. Only a limited number of launching sites will be required. The Atlantic Missile Range and the Pacific Missile Range along with NASA's Wallops Island facility will probably be all that are needed. In space activities, the vehicles will probably account for more than 50% of the total, due primarily to the cost and complexity of the payload and somewhat to the limited production of vehicles that will be called for. In connection with this electronics can be expected to get a greater share of total system expenditures.

At the present time payload costs run to approximately $10,000 per pound. It is believed that this can be lowered to $1,000 per pound, said Dr. Stewart, but probably not much lower due to the high engineering costs. On the other hand, a hundredfold improvement in vehicle costs is considered feasible and achieving this will be a major objective of NASA work. Dr. Stewart also pointed to the possibility of standardizing some electronic systems particularly in regard to telemetry and tracking. Currently, for example, NASA is figuring on only three basically different systems to handle all of its telemetry and tracking requirements.

On a specific program, Project Mercury, Dr. Stewart estimated roughly that ground support equipment including telemetry and recovery would account for only 30 to 40% of total system cost. Dr. Stewart also mentioned that NASA has now created a position for an expert to handle support system reliability and expects to fill this job shortly.

In the opinion of another speaker at the ARS meeting, Dr. C. Stark Draper of Massachusetts Institute of Technology, efficient low cost engineering of support systems may well hold the key to the success of any particular weapon or space system. As illustrated by manned interceptors the complexity and cost of the electronic and other associated equipment added to what might have been originally a fairly effective low cost vehicle, has just about priced and complicated these aircraft out of existence.

In regard to inertial guidance systems in particular, Dr. Draper feels that they are as effective as required, more so in fact than had originally been expected, with little chance of improving the basic physical laws upon which they are founded.

Atlas Ground Support Equipment Installed

Vandenberg AFB, Calif.—Installation of ground support equipment for Convair-Atlas silo launch test facility here is scheduled for completion by Sept. 1, with the site to be ready for use Nov. 30. Silo will be used to solve problems associated with storing Atlas in this type of hardened site, elevating it to the surface for launch, similar to Titan (AW Feb. 22, p. 54).

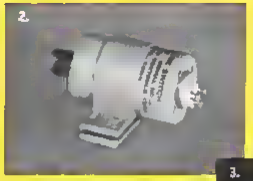
Silo concrete walls are 6 ft. thick at top, decreasing to 2 ft. at bottom, where propellants, elevator mechanism, auxiliary power and other supplies are to be stored. The missile and all equipment in the silo will be mounted in a steel cradle framework for protection against shock from a near-miss by megaton warheads.

Launch control center will be roughly semi-circular—40 ft. at base and 27 ft. high—buried 10 ft. 6 in. beneath the surface and connected to the silo by a 100-ft.-long tunnel.

How the CONDEC GROUP SOLVES PROBLEMS

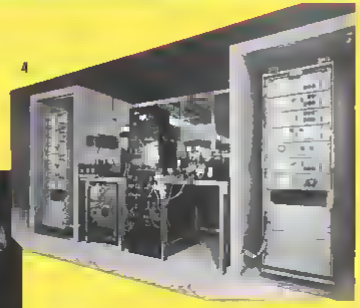
IN INSTRUMENTATION & CONTROL

Vapoflash high temperature probe (to approximately 2000°F) for aircraft and missile systems. Eliminates need of electronic amplification



Typical unit of a full line of pressure switches which control electrical circuits in response to fluid pressure variations

Jet engine air intake control is gas filled thermistor with unique bulb construction. Provides 1 second response and requires no electrical connections



Nerve centers for the sensory devices in the primary system of naval nuclear reactors are the racks at extreme left and right, shown here undergoing test at Consolidated Controls

CONSOLIDATED CONTROLS CORPORATION

The Condec Group provides an unusually broad approach to instrumentation and control through Consolideted Controls Corporation

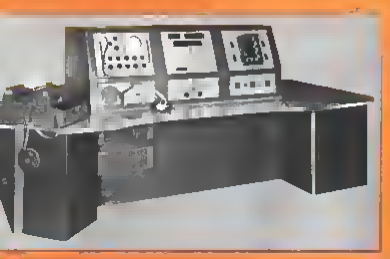
Primary fields of interest include electronic, electro mechanical, mechanical and hydraulic sensing, switching and measuring devices, either as the specific products listed at the right or packaged and integrated into complete systems. Special devices have been developed for many hostile environments in temperature, pressure and corrosive extremes, as well as for monitoring and controlling power extraction from nuclear reactors.

For instrumentation and control in liquid level, temperature, pressure, speed and flow — call on Consolidated Controls. Controls offers a single source for solutions to control problems, calling on other members of the Condec Group as required for development of complete instrumentation and support systems.

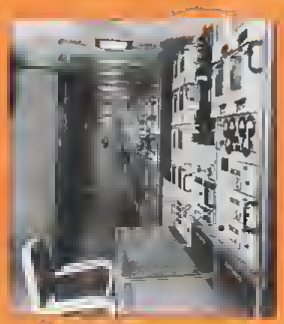
TYPICAL PRODUCTS

1 Vapoflash High Temperature Probes
2 Pressure Switches
3 Ram Temperature Sensors
4 Nuclear Control Systems
5 Ampel Magnetic Limit Switches
6 Altitude Switches
7 Pressure Transducers
8 Precision Machined Springs
9 Flexball Flow Control Valves
10 Hydraulic Servo Valves
11 Fuel Controls
12 Remote Positioning Systems
13 Exhaust Nozzle Systems

IN AUTOMATIC CHECKOUT, DATA PROCESSING AND TRANSISTORIZED POWER SUPPLIES



Universal Test Station automatically tests electronic assemblies by providing programmable AC & DC inputs and comparing response with established limits determining Go or No Go condition and recording data visually and in printed and punched tape form



Interior of instrumentation van supplied to Army Ballistic Missile Agency. It accepts signals from a large number of missile transducers and monitors, processes and records data in forms most suitable for analysis

Low-cost plug in transistorized power supply employs unique heat sink concept, has adjustable output voltages in ranges from 0 to 300 V DC with power up to 30 watts. Regulation ±0.1%

CONSOLIDATED AVIONICS CORPORATION

The Systems Division of Condec's Consolidated Avionics Corporation designs and manufactures advanced types of data processing and automatic electronic test systems, employing specialized digital and analog techniques. Instrumentation and automatic checkout systems have been designed and manufactured for such programs as Jupiter, Atlas, Titan, Discoverer, Polaris and Bomarc. Specialized engineering experience in these critical projects has been accompanied by significant advances in the state of the art.

Consolidated Avionics' Industrial Products Division has developed an advanced line of transistorized power supplies, ranging from super regulated laboratory AC-DC supplies to miniaturized plug-in units of the AC-DC, DC-DC, DC-AC types. A recent addition to the line is a series of digitally programmable DC power sources ranging from 0.1 to 1,000 Volts, in steps as low as 0.1 volt. Special units covering a wide range of input-output combinations have been built for radar simulators, ASW systems, and industrial process control equipment.

TYPICAL PRODUCTS

14 Automatic Test Systems
15 Data Processing Systems
16 AC-DC Supplies
17 Advanced Digital and Pulse Circuitry
18 Digital Logic Cards
19 Security Control Systems
20 DC-DC Converters
21 DC-AC Inverters
22 Laboratory Power Supplies
23 Programmable DC Power Sources

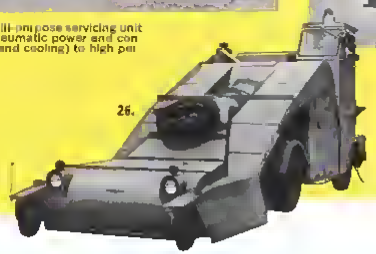
FOR MORE INFORMATION ON ANY PRODUCT, CIRCLE CORRESPONDING NUMBER ON REPLY CARD FOUND IN THIS ISSUE INSIDE THE FRONT COVER

How the CONDEC GROUP SOLVES PROBLEMS

IN AIRCRAFT AND MISSILE SUPPORT

Gas turbine-powered, multi-purpose servicing unit furnishes electric and pneumatic power and conditioned air (for heating and cooling) to high performance aircraft.

Condec mobile shelters, transportable by land, sea or air, provide controlled environment for servicing of electronic equipment in climates ranging from arctic to tropic.



26.

Runway vacuum sweepers built by Condec are credited with saving government millions of dollars annually in jet engine overhaul by cleaning airport surfaces of foreign matter that might be ingested by jet engines.

AIRCRAFT EQUIPMENT DIVISION

The role of Consolidated Diesel's Aircraft Equipment Division in the support of aircraft and missiles is widely known. In 1951 the division conceived, designed, built and delivered the first multi-purpose aircraft servicing unit — the first vehicle combining all necessary ground support functions — electrical, pneumatic and towing — on one chassis. Today thousands of such Condec units are in use at airfields, military and civilian, around the world. Consolidated Diesel pioneered the use of industrial gas turbines as sources of low-pressure air for starting jet engines and has delivered more types of such units than any other supplier.

Aircraft Equipment Division is the world's most complete source of ground support equipment for aircraft and missiles. Provides towing, electrical power, low and high pressure pneumatic power, air conditioning, heating, passenger loading, runway sweeping, hydraulic system filling and testing equipment for maintenance platforms, lubrication, fueling, and mobile shelter for a variety of purposes.

Typical missile projects in which Condec products have been or are being used: Green Quail, Lacrosse, Mace, Discoverer, Nike Ajax, Corporal, and Nike Hercules.

TYPICAL PRODUCTS

24 Multi-Purpose Aircraft Servicing Units
25 Mobile Shelters
26 Vacuum and Magnetic Runway Sweepers
27 Passenger Loading Stands
28 Wheel Mover Units
29 Hydraulic Filling and Testing Carts
30 High Level Maintenance Platforms
31 Lubricating Oil Dispensers
32 Refuelers

IN TESTING

Portable hydraulic test stands for military and commercial aircraft up to 50 GPM pressures to 5,000 psi. Temperature control and special circuitry available.

Hydraulic test stand for use in filling and testing hydraulic system of Lacrosse missile. Similar units available for the maintenance of other missile and aircraft hydraulic systems.

34.

Stationary hydraulic test stand. Flows up to 100 GPM, pressures to 5,000 psi. Temperature, pressure, speed controls. Graphic panels available.

Scientific testing is a specialty of the Aircraft Equipment Division of Consolidated Diesel Electric Corporation, a member of the Condec Group. It is an experienced facility with an extensive record of test systems development.

Specific areas include checking electrical, mechanical, hydraulic and pneumatic operating parameters, and equipment has been produced to check each of these functions separately and in almost every conceivable combination. Units range from simple portable test benches to complex fixed installations for production and design testing of manufactured products.

The Division builds test equipment to specification, to provide the exact type of equipment best suited to the application; and frequently combines its talents with those of other members of the Condec Group when complete support systems require testing apparatus.

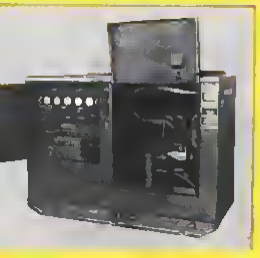
TYPICAL PRODUCTS

33 Portable Hydraulic Test Stands
34 Stationary Hydraulic Test Stands
35 Missile System Hydraulic Filling and Testing
36 Pneumatic Test Stands
37 Fuel Pump, Control, Nozzle and Valve Test Stands
38 High Pressure Oil Filters
39 Auto-Hydradyne Automobile Transmission Test Bench
40 Generator Load Bank Test Stands

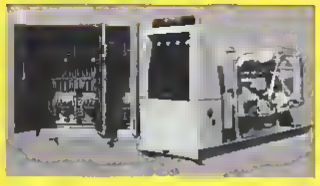
FOR MORE INFORMATION ON ANY PRODUCT, CIRCLE CORRESPONDING NUMBER ON REPLY CARD FOUND IN THIS ISSUE INSIDE THE FRONT COVER.

How the CONDEC GROUP SOLVES PROBLEMS

IN POWER GENERATION AND PROTECTION



Model 403J Condec Diesel Generator Set designed for missile tracking ground support. Operates under such environmental conditions as high temperature, humidity, rain, sand, salt spray, dust, fungus and sub zero temperatures. 15 KW. Close regulation. Surpasses Military Specification MIL G 26727.



Automatic diesel power supply developed for radar installations. Should power supply fail or vary, dual units assume full load in less than 12 seconds. First diesel to take load shuts down other set for standby. Remote control. Automatic recording system relays operational information to central center.

60 KW mobile power source easily moved by two people. Capable of being air lifted. Powered by 3600 RPM gasoline engine. Indicating lights arranged in geometrical pattern for easy reading by inexperienced personnel. Winch and hoist handle 1,000 pounds. Housing pivoted for easy maintenance and repair.

Condec's UPS (Uninterrupted Power Supply). When normal power fails, UPS supplies full load power with absolutely no interruption and full voltage restoration in 1.5 milliseconds. Maintains frequency within 3.5% during transition, 1% in operation.

POWER EQUIPMENT DIVISION

The Power Equipment Division of Consolidated Diesel Electric Corporation provides a wealth of experience in designing and producing electrical generating equipment and related apparatus. More than 15,000 Condec generator sets, from 5 to 250 kilo watts, are now in use around the world.

The latest development of this division is a unique UPS (Uninterrupted Power Supply system) that provides emergency power with no interruption whatsoever, when prime source fails. It provides vital protection for such installations as radar, communications, microwave systems, fire control, electronic switching centers, nuclear controls, military bases and hospitals.

In addition to their own extensive experience in power generation, the Power Equipment Division can call on The Lima Electric Motor Co., Inc. with its 25-year history in the production of rotating electrical equipment.

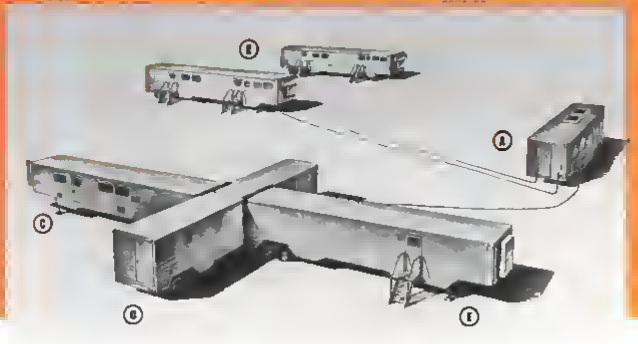
Thus, The Condec Group provides a ready and talented source to design and produce all of the rotating equipment and all of the electrical controls needed to solve any electrical power problems.

TYPICAL PRODUCTS

41 Diesel-Generator Sets
42 Automatic Positive Power Systems
43 UPS (Uninterrupted Power Supply) Systems
44 Mobile Power Sources
45 Adverse Environment Power Units
46 Diesel Driven Pumping Units

IN MISSILE SUPPORT SYSTEMS

The medical system shown here consists of six vans designed as a single system interconnected by power, communication and signal cables so arranged that any particular van can be detached and perform its own function without support of other units. See description on opposite page.



The range of Condec services and facilities for systems development is typified by this bio medical complex, produced for the Discoverer satellite program.

Essentially a completely mobile and self sufficient hospital on wheels, this complex of six integrated units includes an altitude chamber and electronic data handling devices seldom found in ordinary hospitals.

The mobile biological laboratory and medical van were manufactured and equipped by the Aircraft Equipment Division. The altitude chamber, measuring 7½ x 7½ x 8 feet, is one of the largest mobile units ever built. A complete workshop van includes machine tools for minor adjustments of components. Consolidated Avionics designed and produced a complete electronic data control and processing van. Power generating and distribution equipment — a 150 KW diesel-driven generator, switchgear and retractable cables — was provided by the Power Equipment Division.

Condec's Aircraft Equipment Division, provides military and commercial interests with this diverse range of systems engineering and manufacturing skills.

They are ready to help you evaluate your own system requirements and give you a frank appraisal of their ability to manufacture the systems and sub systems you need.

BIO-MEDICAL COMPLEX

A Consolidated Diesel's Power Equipment Division filled this van with 150 KW diesel driven generator, switchgear and retractable cable. When base power is available, engine generator is used for standby. Away from normal power, unit becomes prime power source.

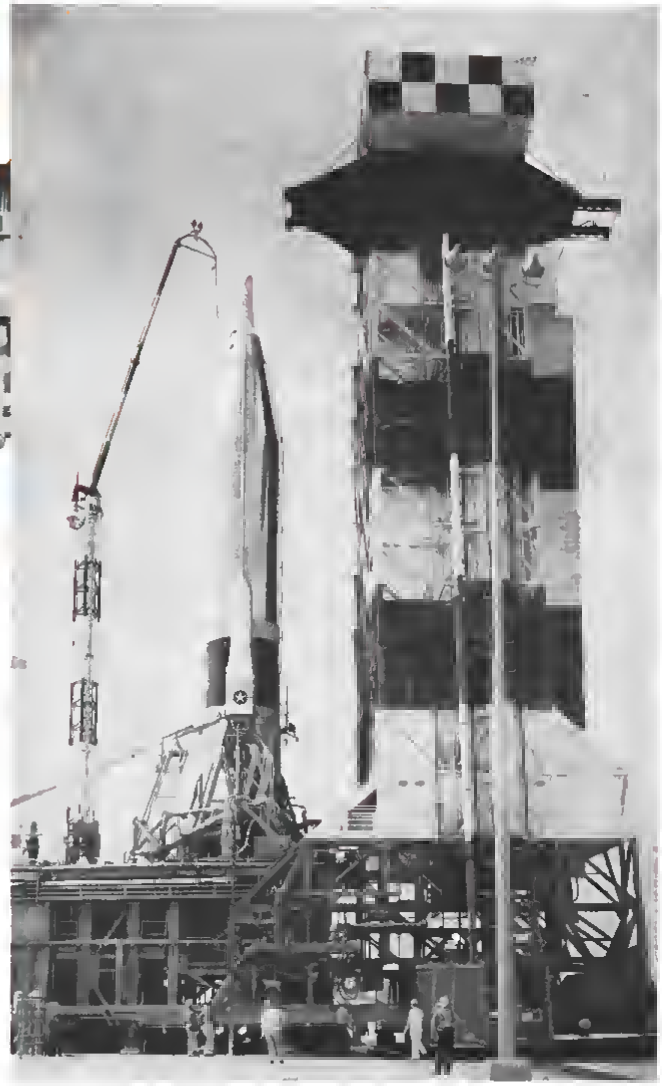
B The mobile biological laboratory van was manufactured and equipped by the Aircraft Equipment Division. Interiors are stainless steel and aluminum. X-ray compartments completely lead shielded.

C Throughout the system as well as in this specialized machine shop, Lima motors and Hammond bronze valves were used.

D Altitude chamber is believed to be one of the largest mobile units ever built. Simulates altitudes of 200,000 feet with unique ability to achieve that altitude in 10 minutes.

E Electronic instrumentation van was designed and built by Consolidated Avionics. Equipment accepts signals from sensory devices attached to specimens in the vans, altitude chamber, or in flight. Signals are processed, displayed and recorded in forms most suitable for analysis.

Arma Guidance Gets First Airborne Test



Arma all-inertial guidance gets its first test on USAF-Convair Atlas 42 D (AW Mar. 14, p. 35). Tube from launch pad to guidance package permits clear last minute line-of-sight reading of optical setting. Package was actually to guide the missile on a second test flight.

EASTERN AIR LINES Douglas DC-8 is powered by four Pratt & Whitney JT4A-3 turbojets rated at 15,800 lb. thrust.

Aviation Week Pilot Report:

DC-8 Handles Well Through All Regimes

By Richard Sweeney

Long Beach, Calif.—High degree of stability and controllability of the Douglas DC-8 jet transport when maneuvering along the outer edges of its performance envelope was demonstrated during a flight evaluation by this AVIATION WEEK pilot.

The airplane's inherent flyability through all regimes with its power flight controls off, as well as on, bore out indications given in a short flight last year (AW Mar. 30, 1959, p. 79).

DC-8s flown in the evaluation were in Eastern, United and National airline configurations using Pratt & Whitney JT4A-3 turbojets rated at 15,800 lb. dry static thrust. The aircraft incorporated wingtip extensions and slots (AW Feb. 1, p. 28). Takeoff gross weight was 196,000 lb. for the Eastern plane, approximately 210,000 lb. for United and National aircraft.

In level high-speed flight at 35,000 ft. and 36,500 ft., a low amplitude, high-frequency buffet appeared at speeds ranging from Mach .865 to Mach .87, and did not increase in severity until Mach .88 or higher. The buffet-Mach number relationship remained in the same range when the aircraft were flown without use of the pitch trim compensator system which is built into the DC-8.

Although the DC-8 incorporates hydraulic full-power aileron and rudder controls, the elevator is manually actuated through aerodynamic tab. The pitch trim compensator (PTC) system gives a zero stick force by repositioning the control column throughout the speed range where sweptwing airplanes undergo a pitch trim change. This system gets information from the copilot's normal static source which is fed into a Mach computer. The computer output controls an electric motor which drives the screwjack actuator that repositions the control column by mechanical linkage.

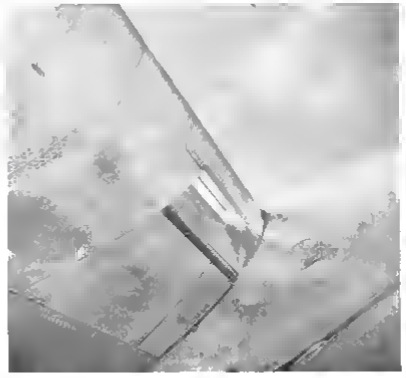
Emergency Function

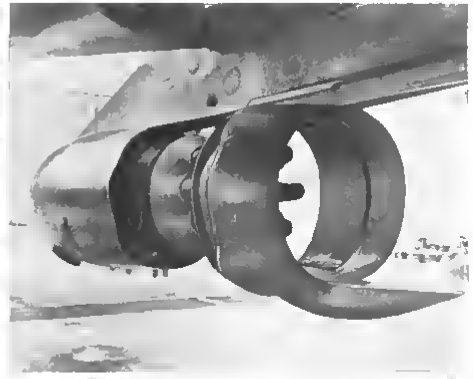
Pitch trim compensator system can be used to partly help overcome a jammed stabilizer condition, by placing its three-position (test, automatic, override) control switch in a test position. This applies full pitch trim compensation toward a nose-up attitude, helping to relieve stick forces at landing if the stabilizer has jammed in high speed or cruise (nose down) attitude.

Flying the DC-8 through the tuck region with the PTC blocked out (placing control switch in override position puts the PTC in neutral and keeps it there) showed the aircraft to have excellent longitudinal stability and controllability. A tuck tendency appears at approximately Mach .865, where it is barely felt, then builds up to a maximum at about Mach .88. The aircraft was flown through the tuck and on up to Mach .89, using the left hand only on wheel with the right hand kept on

DC-8s flown in the evalution were in Eastern, National and United configurations. The United Air Lines aircraft had a takeoff gross weight of approximately 210,000 lb.

COCKPIT of United DC-8 shows relatively uncluttered flight instrument panels for pilot and copilot. Engine panel is between the stations. Note added visibility afforded by eyebrow windows. Autopilot controls, navigation and communication controls, aileron and rudder trim control wheels are on the flat section of the pedestal aft of throttles and fuel controls.





INBOARD SLOT on wing leading edge of DC-8 is open (left). Hydraulic actuators move the doors which cover the slots during normal flight regimes. Slot covers close when flaps reach three degrees in retraction cycle. Thrust ejector is extended (right). Thrust reverser doors are incorporated into ejector and deflect exhaust through louvers on each side of the ejector.

DC-8 Study Guide

Long Beach, Calif.—Douglas Aircraft Co. flight department is compiling a 200 page Flight Study Guide as part of the DC-8 jet transport program. Written by pilots for pilots, it presents certain of the data from the FAA-approved flight manual, which is much wider in scope.

This parallels a Flight Study Guide which Douglas compiled for its DC-6 A and B transports, which was used in pilot ground school training as well as flight work. The DC-8 guide will be fairly detailed. It will explain flight characteristics of large, swept wing jet transports, including interrelationship of such factors as roll and yaw and the time it takes for thrust buildup after throttles are applied in a go-round.

Oriented toward specific flight techniques to be used with the DC-8, it will go through an entire flight cycle from engine start to engine shutdown at destination, including taxi, takeoff first and second segment climbs. Two en route planning charts are incorporated, one for high speed cruise, the other for maximum range cruise. Structural design philosophy as it affects piloting techniques also is outlined.

engine controls. At no time did forces feel excessive for effective single hand controlling.

Further indicating the DC-8's high degree of stability and controllability, there was no significant increase in rudder or aileron sensitivity through this speed spectrum in the manual (power off) mode, and while control forces increased, they remained acceptable throughout the high Mach sampling. Turns at Mach numbers above Mach .865 can be accomplished with one hand control, although higher forces slow the roll rate. Using both hands on turns the roll rate is better but not as high as with powered controls.

High control deflection was applied to the right to induce Dutch roll at 35,000 ft., Mach .85, with PTC, rudder and aileron power off. The aircraft was restrained in pitch axis only after controls were released at highest deflection. The DC-8 returned to straight-and-level flight in one half cycle oscillation, over a time period of 35 sec. Control forces required to reach desired deflections were high but within expected limits.

Stall Characteristics

DC-8 stall characteristics were sampled under various conditions of altitude, gross weight, control system mode and configuration.

With PTC, aileron and rudder power off a stall at 12,000 ft. was made with gear down, takeoff-and-holding (25 deg.) flap setting, throttles closed, and at 10 deg. nose up attitude. Trim speed for this stall (and most others) is approximately 160 kt. IAS, and trimmed out above this speed the airplane runs out of elevator before stalling.

The aircraft handled smoothly throughout the maneuver. There was no tendency to fall off on a wing. Aileron effectiveness was good and rudder worked well as lateral axis control throughout, including a stall break phase where aileron effectiveness is at the minimum.

The airplane's stick-shaker stall warning became operative at 119 kt. IAS, the buffet started at 116 kt. IAS and the stall break occurred at 109 kt. IAS. Full elevator displacement had occurred by approximately 112 kt. IAS but the airplane retained its attitude down through the break, leaving the impression of a last hesitation before the nose finally fell through.

Standard power recovery technique was used, and the aircraft lost no altitude from starting point of the maneuver.

A second stall was performed under the same conditions with two exceptions—a 1.25 engine pressure ratio (EPR) power setting was used and attitude was changed to 20 deg. nose up.

Stall buffet started at 111 kt. IAS and break occurred at 101 kt. IAS. A 30 deg. nose down recovery was used, with no change in power setting throughout the maneuver. Despite the relatively steeper attitude, lateral stability and controllability remained good. The right wing had a tendency to drop after the stall break, and both aileron and rudder were used to recover level attitude due to slower roll rate obtainable with manual tab controls and relative severity of the nose-down attitude assumed for speed recovery.

Additional Stalls

Additional stall sampling was done at 20,000 ft., using PTC and power flight control, in clean and partial flap down configurations. No engine power was used.

Using a relatively shallow attitude, clean configuration and power off the airplane margin narrowed somewhat between start of buffet and stall break, the latter occurring at 138 kt. IAS. Repeating the stall, but using 25 deg. flap, the aircraft encountered severe buffet at considerably lower speed and the stall break occurred at 119 kt. IAS.

Additional stall sampling was done in clean configuration, starting from the same altitude except that this time the controls were kept full into the stall and a secondary (or accelerated) stall was allowed to develop through the break. First stall break came at 135 kt. IAS, aircraft dropped through with

Third Vertical Fin Added to Fairey Rotodyne

Fairey Rotodyne tipjet VTOL transport has been modified to include a third vertical fin centered on the tail section for increased performance at high speeds. Other changes include rotor head fairings and shortening of jet efflux pipes outboard of engine nacelles.

good characteristics, and started entering the secondary stall. Break in the secondary, which was preceded by an emphatic buffet and shaking of the entire airplane, came at 137 kt. IAS, and the aircraft tended to wobble a bit about the lateral axis after the break. However, full recovery was accomplished without difficulty, and the airplane remained fully controllable laterally throughout the entire dual stall.

Reverse Thrust

One high rate descent was done using reverse thrust to drop from 35,000 ft. to 20,000 ft. The rate approximated 8,000 fpm., which is considerably less than maximum allowable for the DC-8 (close to 13,000 fpm.). Only engines 2 and 3 were reversed; speed was held to Mach .75 and the aircraft flew smoothly during descent which was done with the power flight controls operating.

DC-8 engine-out characteristics were sampled in a full asymmetric power situation for a simulated approach and go-around starting at 12,000 ft. and descending to 11,500 ft. at 500 fpm. rate of descent. Standard approach configuration was used except that power flight controls were off, and gross weight approximated 180,000 lb.

Approach airspeed of 175 kt. IAS was used since minimum control airspeed for two-engine-out situation is 155 kt. IAS. Fairly high EPR was a help on operative engines throughout the approach, to hold the descent rate to desired value. Full power was applied at the chosen minimum altitude (which would have been the point of breakout or go-around in an actual landing approach).

Aircraft's rate of descent was stopped as desired and a positive rate-of-climb established. However, full asymmetric power required full rudder pedal travel and a high degree of available aileron travel also was used to hold altitude, leaving little control-throw available in case of unexpected situations.

Considering the altitude, gross weight, two-engine-out condition and manual flight controls, an aggregation of conditions which would be only one step from a crash if all actually happened at once in flight, the aircraft performed well. The pilot will work hard if he encounters this combination of circumstances, but in actual operations, additional fuel would be burned or dumped prior to the approach, which would be made at considerably lower

GE Aft Fan Engines, Pods Tested on RB-66

Convair 600 jet transport pods and General Electric CJ805-23 aft fan engines are tested on this leased Douglas RB-66 bomber. Plane has been flown at Mach .85 at 35,000 ft.

altitude and these two factors alone—reduced fuel weight and low altitude—would increase his margins over those found in evaluation maneuver.

Several ILS approaches were flown with control power off, at Ontario, Calif., where some turbulence late in the approach is almost always evident. Gross weight called for 160 kt. IAS in approach configuration, decreasing to 145 kt. when flaps are lowered to 35 deg.

Flare speed would have been 130 kt. had a landing been made.

Aircraft responses were good throughout the approaches, including the turbulence which occurred about a half mile out from the middle marker, and through the full power application for pull-up and go-around.

Jet transport takeoff and landing are completely standard in the DC-8. The aircraft accelerates well at the gross weights at which the three aircraft were flown in evaluation, both at takeoff and aborted landing.

With nose wheel steering incorporated into rudder pedals on the DC-8, takeoff is easier because the pilot can keep one hand on the controls and the other on the throttles, instead of switching one hand from the nose steering wheel to the controls during takeoff. Steering throw is sufficient with the pedals for most taxiing with the wheel required only for sharp turns.

One noticeable characteristic at takeoff was the spread between rotation speed (V_r) and unstick (V_u) speed. For Eastern Air Lines DC-8, N8604, for example, takeoff data for the 196,000 lb. gross weight and 60° runway temperature showed V_r as 123 kt. IAS and V_u of 140 kt. IAS.

Time to accelerate to 100 kt. was 19 sec., which the airplane bettered by one second. Rotation and liftoff were smooth, with initial climbout made at V_2 plus 10 kt. for noise abatement until past 2,000 ft. Engine settings were 2.47 EPR for takeoff, 2.19 for maximum continuous and 2.1 for maximum cruise.

On landing, full (50-deg.) flaps usually are extended at the middle marker and final slowdown to flare speed started. Landing rotation was smooth and not excessive. Technique is to complete rotation and cut all power, hold attitude and allow the aircraft to fly itself onto the ground. The nose is lowered within a second or two, but not immediately after main gear contacts runway.

Spoiler Operation

Spoilers extend automatically when the nose gear strut is compressed on landing, if the cockpit control is in the "armed" position. Spoilers also can be lowered manually with the cockpit control lever.

Thrust reversing system has electrical switches on the pilot's overhead panel controlling extension and retraction of ejectors in inboard and outboard pairs.

Thrust reverser doors are incorporated into the ejector, and deflect the exhaust gas stream through louver systems on each side of the ejector to attain reversal. Doors are pneumatically actuated, and are controlled by initial movement of the thrust reverser levers which are incorporated on main throttles. As reverser levers move up and aft,

Hughes Aims Model 269A at Civil Market

Hughes Model 269A helicopter, shown during a public demonstration has completed Army evaluation tests (under designation of YHO 2HU). Craft is aimed at civilian market (AW Mar. 21, p. 37) at a basic price of $22,500. Powerplant is a Lycoming O360-C2B.

they control reverser door opening and closing, and mechanical stops prevent further lever travel until doors have left the full open position. As doors leave the fully faired (open) position, micro switches are actuated which cause lever stops to be withdrawn. Pneumatic reverser door actuators have only two positions, and start of opening cycle indicates doors will close. In the event of pneumatic failure, doors will be blown back into open position.

Additional up and aft lever travel after stops are removed applies engine power for reversing.

A pair of status lights on the pilot's panel indicates ejector-reverser status. A blue light indicates ejector extended or retracted position, an amber light indicates reverser doors open or closed.

Slot operation on the DC-8 is automatic, with hydraulic actuators moving the doors which cover slots during normal flight regimes. Doors open in about one second when wing flaps reach eight degrees while going down. A mechanical down past center lock holds covers open if hydraulic failure occurs. Slot covers close when flaps reach three degrees in retraction cycle. Slot cover opening and closing is controlled by actual flap position as taken off the flap hydraulic actuator.

DC-8 cockpit layout is excellent, and the airplane can be operated from the pilot's seat and systems engineer's position. Flight instruments in front of the pilot and copilot are in the basic T arrangement. Engine gages are in the center panel and from top to bottom are engine pressure ratio, exhaust gas temperature, N_1 (rear compressor spool) tachometer, and fuel flow indicator. On the pilot's side of the engine gage panel are outside static and ram air temperature gages; on the copilot's side the landing gear retraction handle.

Center pedestal adjacent to instrument panel has radar controls, scope and ADF controls. Aft of this are the pilot's handgrip elevator trim control, friction lock, throttles and flap control handle. Between the throttles and flap control is the spoiler control lever. Immediately aft of the throttles are the four fuel-control units which operate only in on or off position for JT4A-3 engines. Between No. 2 and 3 fuel controls is an emergency electrical stabilizer trim control which moves the stabilizer jackscrew in case of hydraulic failure.

On the flat section of the pedestal aft of the throttles and fuel controls are the autopilot controls, navigation and communication controls, aileron and rudder trim control wheels.

Control column wheels have electrical elevator trim switches, autopilot disengage button and microphone button for use when the oxygen mask is being used. Warning light panels are installed in various positions throughout the cockpit. The overhead pilot panel controls various systems and sub systems, and includes starting buttons.

DC-8 start procedures for JT4 engines are very simple—fuel boost pumps are turned on, the ignition start switch is pushed in and when the systems engineer reports an indication on oil pressure gage and N_1 (front spool) tachometer indicates compressor rotation, fuel control is moved to "on" position. Starter button cuts out automatically at the preset time or engine speed.

One particular DC-8 feature which makes ground handling easier for pilots is the castering rear pair of wheels on each main gear bogie—the aircraft can be turned around at the runway end or similarly restricted spots, and in a small radius, without tire scrubbing.

Vanguards Delivered From 1961 Will Have Increased Load Capacity

London—Vickers Vanguard turboprop transport, with new weight specifications (AW Mar. 14, p. 50), will be offered to all new customers for delivery from 1961 on.

Position with regard to the last 14 aircraft from British European Airways and 20 planes for Trans-Canada Air Lines is not yet clear, but there is a possibility that some or all will be uprated to the new Mk. 2 specifications.

The Mk. 2 Vanguard's payload has been increased 8,000 lb. and gross weight has been hiked from 141,000 lb. to 146,500 lb. Increased load capacity arises from an increase in the zero fuel weight from 121,500 lb. to 122,500 lb., the result of measured wing stress levels being lower than design values. Additional local reinforcement needed adds only 600 lb. to the empty weight.

Since the maiden flight of the Vanguard just over 12 months ago both the airframe and the Rolls-Royce Tyne turboprop have been proved relatively trouble-free.

The airframe itself, which is now nearly three quarters of the way through its certification program, has escaped major modifications. The tail fin has received a small ventral extension and vortex generators have been placed upstream of the ailerons which were underpowered near stall.

The only incident reported by Vickers during the thousand hours of flight test time logged was a high-speed binding made with full brake at touchdown, the anti-skid device having been cut out. The starboard tires burst, but damage was confined to the superstructure in the wheel bay.

The twin-spool turboprop engine, which develops 5,545 ehp. and has air-cooled blading in its high-pressure turbine, has never been feathered due to engine malfunction throughout approximately 4,000 flying hours on the six Vanguards now flying in the certification program, Vickers says. Since its first flight in June, 1956, the engine has been feathered only twice—once for a fuel system failure, and once for an oil seal failure—during 4,000 development flying hours in two de Havilland Elizabethan and one Avro Shackleton flying test beds. Bench testing hours of the engine now total 10,000.

A development engineer from Rolls-Royce said that the Tyne, in spite of a pressure ratio of 13.5:1 and its very high inlet gas temperature (reported to be 1,400K), had given less trouble up to this phase of development than any other Rolls-Royce engine including the Dart.

A contributory factor to its behavior is that it uses scaled-down Conway compressors, Avon and Conway combustion systems and turbine details as the extended blade root platform which Rolls-Royce has used in Dart, Avon and Conway engines to reduce disk temperatures, the engineer said.

To date there have been no turbine blade or disk failures on the engine.

Development problems, now over, come have largely been associated with the oil seals and main bearing difficulties associated with a coaxial shaft system. The seal problems arose in locations where seal effectiveness depended on the full compressor air pressure and therefore leaked in the start and shut-down phases.

The engine now on flight development which will power all BEA's aircraft has a lower rating than the Tyne R1s.11 which will be the standard version for all deliveries from 1961 onward and for the TCA aircraft.

To get higher shaft speeds and temperatures the Tyne 11 uses the latest blade material, Nimonic 105. Cruise fuel consumption figures for the Tyne 11 of 0.388 lb. thrust equivalent horsepower hour (25,000 ft. ISA at 370 kt.) are the lowest announced for a gas turbine and equal the figures of Wright Turbo Compound piston engines but for less than half the specific weight, Rolls-Royce says.

In spite of the high inlet temperature, blade metal temperature in the Tyne, Rolls-Royce maintains, is not higher than that used on the Dart which now has an overhaul life of 2,400 hr. totally free from scheduled component changes of any kind.

Rolls-Royce's main concern in the turbine cooling system is the maintenance of the air supply up to the disk, and special temperature monitoring equipment has been developed for this part of the circuit. Failure of the flow to diffuse evenly among the blades is considered a less serious hazard as debris arising from blade failure can be contained in the nacelle.

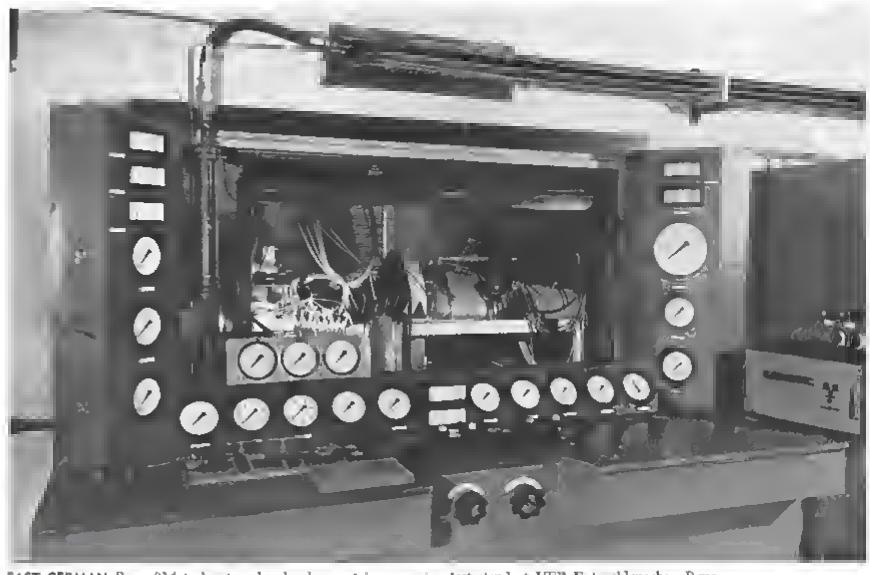
Major portions of the structural test program which have now been completed include the testing to destruction of a complete airframe under loading representative of a 2.5g maneuver. Fatigue data has been assessed on wing torsion box and fuselage specimens besides the conclusion of tests on a multiplicity of smaller assemblies.

Hydraulic and electrical test rigs on which the Vanguard's hydraulic and electrical systems and components were proved before first flight are now engaged on fault analysis of production components and on the establishment of the overhaul life of system components. Fuel and air conditioning systems are also approaching the end of rig test programs.

Vickers uses these systems test rigs to check every component before it is installed in the production aircraft.

Hiller 12E-4 Offered for Civil Use

First configuration details of the four-place Hiller 12E-4 helicopter designed for civil use are shown in this model. The helicopter can be obtained as a kit modification to the standard 12E or as a production aircraft. First production models will fly in 1960.



EAST GERMAN Pirna 014 turbojet under development is on engine test stand at VEB Entwicklungsbau Pirna.

Pirna 014 Aims at Low Fuel Consumption

By David A. Anderton

Leipzig, East Germany—Unusually low specific fuel consumption is claimed for the Pirna 014 A-1 single-spool turbojet now in production in East Germany. (AW Mar. 21, p. 76)

Brochure figure for the East German engine is 0.87/lb./hr., a value directly comparable with some of the best contemporary engines in the United States and Great Britain. But in physical characteristics, weight and thrust, the 014 is in a class with now obsolescent second-generation Western jet engines.

Pirna 014 A-1 is rated at 7,260 lb. sea-level static thrust at 8,100 rpm. Cruise thrust is 6,050 lb. at 7,550 rpm. Dry weight is 2,310 lb.

Claims Questioned

The low specific fuel consumption combined with a turbine inlet temperature claimed much lower than for comparable foreign engines, have caused more than one American powerplant engineer to wonder which of the Laws of Thermodynamics have been repealed in East Germany.

East German spokesmen attribute the performance of the engine to its design requirements and to no unusual features of design. Four of these turbojets are slated to power the Type 152 58-seat transport now under development at the VEB Flugzeugwerke Dresden. Performance requirements for this airplane were the design goals of the engine development teams at the VEB Entwicklungsbau Pirna.

Further Development

Further development of the engine is scheduled as a top priority project, according to Prof. Schelmost, manager and chief engineer of the Pirna operation. He specified increased thrust for the same engine weight, increased time between overhauls, and reduced spare parts requirements, giving a "... further overall improvement of the economy."

Schelmost also indicated that a new powerplant project was in development at Pirna, but declined to say anything except that its specific fuel consumption would be even lower than that of the 014 engines. This project may be the bypass version of the Pirna reported earlier (AW Mar. 14, p. 23).

Official sources have said that the Pirna 014 is in production, presumably at VEB Industriewerke Ludwigsfelde, a factory in a village southwest of Berlin near Potsdam. This plant is responsible for turbojet production, while development is done at Pirna, southeast of Dresden.

First production engines off the line will carry a guaranteed 1,000-hr. time between overhauls. Specific production quantities were not available, but one engine was given by nameplate data on the single engine shown at the Technical Fair here. It was a preproduction engine of the 014 A-0 type, rated at 6,925 lb. thrust. It had been built this year, and was No. 24 in the series.

Other official sources say the engine passed its East German certification tests last August and now is cleared for flight. The flight test program reportedly is in full swing.

Conventional Layout

The Pirna 014 series is of conventional layout, with a 12-stage axial-flow compressor, a cannular combustion chamber, a two-stage axial-flow reaction turbine and a fixed thrust nozzle. Overall length of the engine is 132 in. from inlet face to exhaust outlet face, and maximum diameter is 38.8 in.

Engine inlet is formed between an annular oil tank and a magnesium-alloy "bullet" which carries the main front rotor bearings and the bevel gear which

is the starting point for the trains that drive all the engine accessories. A 6 kw. starter is mounted inside the "bullet" driving the rotor through a four gear train. Oil system components are attached at the bottom of the annular oil tank, and fuel and control system components are mounted on a bracket at the top of the compressor housing. Supporting struts for the bullet are connected to the powerplant thermal deicing system.

Compressor casing is built using conventional monocoque technique to get low weight, high rigidity and high strength.

Airflow through the 12 stage compressor is about 110 lb./sec., and the pressure ratio across compressor is 7:1.

Blades for the first and second stages of the compressor were made by the Napercast process by D. Napier & Sons, Ltd. About 13,000 blades have been delivered by the British company to the East German developers of the Pirna engine.

Axial Forces

Compressor and turbine rotor are rigidly connected, with axial forces on the main bearing reduced to the minimum by a relieving piston system.

For starting and faster acceleration, there is a bleed-off system built into the compressor housing, automatically actuated by the engine control system.

Annular combustion chamber combines 12 burners in a single housing with one fuel injector per burner and two spark plugs at 90 deg. to each other for ignition. Construction is conventional double-walled shell to reduce heat transfer from the burner.

Individual burners have a venturi section at the upstream end, where the fuel is injected, and then a mixing and burning length about equal to one diameter of the burner can. Downstream of the primary burning zone a series of triangular fins, fastened radially to project in from the outer wall, apparently serve to smooth any combustion disturbances before the hot gas is discharged into the turbine nozzle box.

Uncooled Blades

Two-stage axial-flow turbine is a reaction type, using uncooled blades made out of a nickel chrome alloy. Turbine blades are die forged, and the stator blades are precision cast. Floating bearings inside the combustion chamber support the turbine shaft.

Lubrication system features independent oil suction pumps for the main lubrication points. System pressure is about 60 psi. By making the oil tank an annulus and part of the engine intake, there is no need for a separate oil cooler.

The conventional single-lever control system is used for operation of the Pirna 014. Starter is battery-operated, and is normally driven by aircraft batteries rather than by an outside battery cart. This may have been done simply because proper ground equipment was not available at the time of the design, or because it was felt desirable to give independence of a ground environment.

Starting Cycle

Starting cycle is automatic and initiated by the pilot with a starter switch. When the engine is up to ground idle speed, the automatic control can be overpowered by the pilot's control. A constant speed governor system is linked to the controls to keep the engine rpm constant during variations in flight speed and altitude. Fuel system pressure is about 1,000 psi.

Company says that post-flight inspection of the engine should take only five to eight minutes, and that a 50 hr. inspection should last between one and two hours.

The 50-hr. check would generally be limited to cleaning the oil and fuel filters and a general visual inspection of the engine, according to the company.

Engine has a three-bolt suspension system, with the points located in one plane near the center of gravity.

Takeoff thrust rating of the engine has been increased during the last year, probably because of some increases in gross weight of the Type 152 transport and also because of more realistic takeoff requirements. Current thrust of 7,260 lb. is 335 lb. over the figure for the Model A-0 engines, and was achieved by increasing the engine rotational speed by 100 rpm. Cruise thrust and rpm. remain unchanged "for increased life."

Last year's brochure figure for specific fuel consumption was 0.85, and has since climbed by a couple of points to the 0.87 figure now being quoted.

But in addition to increased takeoff thrust, the dry weight of the engine has dropped about 22 lb. This is a small amount—about 1%—and it only improves the thrust-weight ratio from 2.97 to 3.14.

This latter figure is beginning to crowd the thrust/weight ratio of first-generation two-spool engines.

Design Background

It's difficult to trace the design genealogy of the Pirna 014 engines. The official viewpoint is that they are the "... first powerplants developed in East Germany." This is a true statement.

But Western observers familiar with German developments during World War II see a similarity to the Junkers 012 wartime turbojet in the Pirna engine.

Schelnost said some contributions to the design were made by Russian engineer collaborators, but that the original concept of the engine had stood the test of time and had been retained. This latter point may be a veiled reference to the fact that the basic concept was the Junkers engine.

One of the 012 engines had been completed by the end of the war at the Junkers Motorenbau-Werke, then located in Dessau which is now in the territory of East Germany.

It was taken to Russia at the end of the war, along with the development teams.

One of the technicians who went with the engine, F. Brandner, described the status of the 012 program after it was revived in Russia (AW Apr. 8, 1957, p. 53). Brandner said the 012 and its development team were set up as the Junkers Collective at Kuibishev on the Volga River, and given a series of development jobs to do that eventually led to the Type K turboprop engines used now in the Russian Bear bomber.

Advanced Design

The 012 Junkers engine was very advanced for its day. It had a design thrust rating of 6,630 lb. at 6,100 rpm., and a specific fuel consumption of 1.06, according to Brandner's data. Com-

pressor was a 17 stage axial-flow unit with a pressure ratio of 4.5, and an air flow of about 130 lb./sec. The combustion chamber was developed in 1947, he said, and consisted of 12 individual burners joined in a single annulus. Combustion efficiency then was 95% and the pressure loss was about 7%. A two-stage axial flow turbine completed the rotating part.

Brandner said that turbine blade failures stopped the program before it was completed, and the mercurial Russians put the Junkers collective to work on another job. Two years had been spent in work on the Type 012 engine, and about all it furnished according to Brandner, was some experience for the collective.

Eventually some of these specialists returned from the Soviet Union, and many stayed in East Germany. Schelmost said that these returnees were given facilities, large budgets, development and production facilities, and a priority for technicians and tools. They started with nothing but a few buildings, and built factory areas, test stands and a production facility.

Test Stands

Powerplant testing started in 1956, but the factory is not yet completed. In addition to the single original test stand, there are now several more, which are capable of taking a complete powerplant nacelle.

Apparently the development of the powerplant package is assigned to the engine developers in East Germany, as it is to Rolls-Royce for example in Britain.

A gas dynamics laboratory has been added to the facilities, Schelmost said, to provide a fundamental research facility for powerplant work.

Starting Date Uncertain

It isn't possible to put a starting date on this chronology, because whatever date was chosen would have to be carefully qualified.

Would one choose the starting date for Junkers' wartime work, or would a better selection be the time that the Russians re-initiated development of the 012?

About all that can be firmly said is that the first test runs of complete jet engines began just four years ago, and in that time, a conventional engine has been developed to produce a moderate amount of thrust with an unusually low fuel consumption.

In addition, more powerful versions of the engine are being tested in flight and on the ground, a bypass model is probably being developed, the basic production engine has passed its official test in East Germany, and development work has started on a trio of small low-power industrial gas turbines.

Pirna Develops Three Small Gas Turbines

Leipzig, East Germany—Trio of small gas turbines rated at 130 eshp. has been developed by VEB Entwicklungsbau Pirna, the East German turbojet agency also responsible for the Pirna 014 commercial jet engines.

Designated as Pirna 017 models, the three engines have been undergoing research and development testing since the end of 1955 at Pirna. They were designed as a family for aircraft or industrial purposes.

All engines in the series have free turbines for shaft power output, a single-stage centrifugal compressor, individual combustion chambers and a single-stage turbine driving the compressor.

The Pirna 017 A is designed for research, and there has been no production of the engine. It is laid out so that fundamental engine development can be done with a minimum of effort and components can be altered to study their effects on over-all performance.

Nominal rating of the engine is 130 eshp. at 32,000 rpm. Air throughput is about 3.1 lb./sec., and the compressor pressure ratio is also 3:1. Exhaust gas from the turbines is collected and discharged radially through a pair of nozzles.

Specific fuel consumption of the engine is about 1.4 lb./eshp./hr. Weight of the engine, including starter and accessories, is 264 lb., which gives a power weight ratio of just about 0.5 hp./lb.

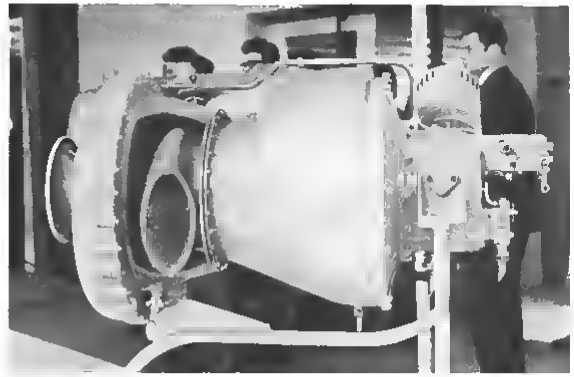
The engine is 43.3 in. long, and has a maximum envelope width of 21.2 in. The Pirna 017 A was designed to have a useful life of 1,000 hr., enough to get endurance runs in 50-hr. increments for the various components.

During the work with the research engine, Pirna engineers developed an annular combustion chamber with rotary fuel injectors. This shape of combustion chamber lent itself to a layout built around heat exchangers to reduce the specific fuel consumption, and so they developed and tested a cross-flow heat exchanger for the engine. The exchangers and the annular combuster were joined to make the Pirna 017 D.

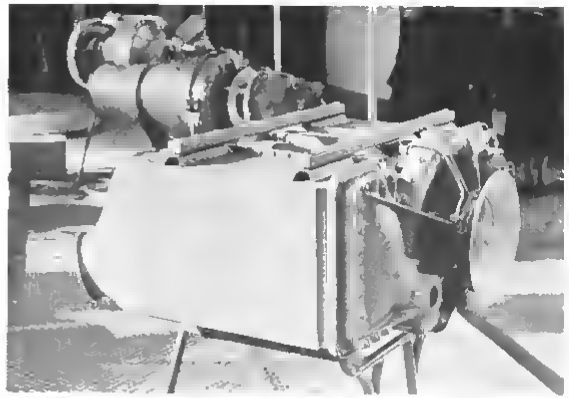
Weight of this unit has been increased to about 440 lb., and the specific fuel consumption is reduced about 40% to between 0.84 and 0.88 lb./eshp./hr. Engine rating is still 130 eshp. at 32,000 rpm.

Layout of the Pirna 017 F version, developed as a powerplant for trainers or ground equipment, is that of a conventional straight through gas turbine.

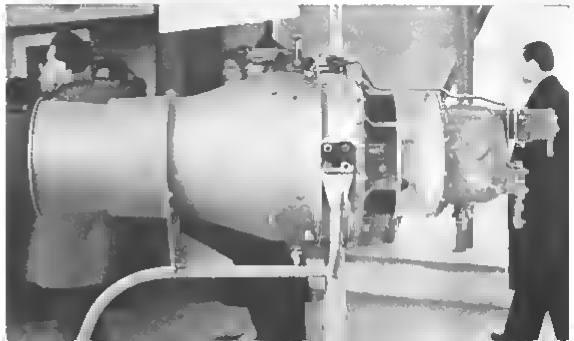
Engine is also rated at 130 eshp., its specific fuel consumption is 1.32 lb./eshp./hr., and the powerplant weighs 220 lb.



EAST GERMAN PIRNA 017 A gas turbine above is a research engine. Pirna 017 D below evolved from the research program. Engines were exhibited at Leipzig Fair.

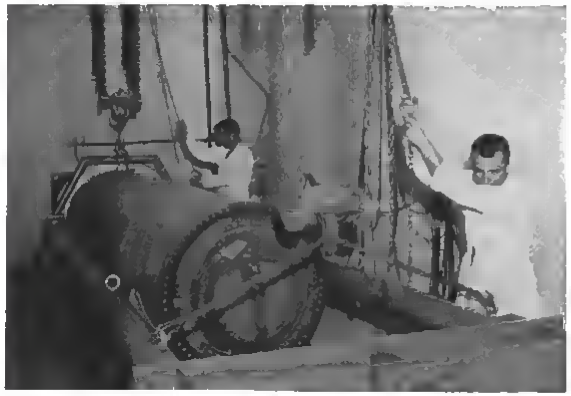


PIRNA 017 E was developed as a powerplant for trainers or ground support equipment.



Grand Central Aims at Bigger Space Role

By Russell Hawkes



SOLID PROPELLANT rocket engine is positioned in its cradle (above) at Grand Central Rocket Co.'s Beaumont proving grounds prior to static testing. Below, a large solid rocket engine is placed in a pit oven for curing. Grand Central is proposing solid propellant space boosters of up to 15 million lb. thrust.

Redlands, Calif.—Lockheed Aircraft Corp.'s purchase of a half interest in Grand Central Rocket Co. will give Grand Central strong new financial backing for its effort to find technological advances to improve its competitive position.

The move doubles Grand Central's capitalization and places behind it the resources of three large corporations—Lockheed, Food Machinery & Chemical Co., and Tennessee Gas Transmission Co. The latter two exercise their share of control through a jointly owned subsidiary, Petrotex Corp.

Grand Central has committed itself to protect the proprietary rights of its customers who are in competition with Lockheed.

Management of Grand Central is convinced that the trend toward solid propellants in missiles will carry over into space exploration. Much of the company's effort to gain a technological lead is slanted toward space applications.

Study Projects

Among the development and study projects being pushed by Grand Central in its competitive drive are:

- **Hybrid liquid-solid rockets** being worked on in conjunction with Marquardt Corp., using unusual propellant combinations and liquid injection methods.
- **Low chamber pressure**, high mass ratio solid propellant upper stages for space vehicles being studied for National Aeronautics and Space Administration. One of these is a radically new motor called Wolf.
- **Advanced solid fuels** development with such materials as Nitrasol and CBAN (carboxylated-butadiene acrylonitrile), promising more perfect fuel-oxidizer mixture ratios without sacrifice of good physical properties.
- **Solid propellant canard** jet reaction controls development along the lines of those used in Western Electric Nike Zeus and proposed for Douglas GAM-87A Skybolt.
- **Large solid propellant space boosters** using segmented construction for safe, easy transportation and final assembly at the launch site.

J. W. Sessums (USAF, ret.), chairman of the board, says he is confident about the future of solid propellants in space exploration. He says the advantages of simplicity and reliability are as valid for space missions as for military missions. Grand Central experts are willing to concede that the specific impulse of solid propellants will never catch up with those of liquid propellants, but they predict the margin will narrow. Rate of improvement in solids has been faster than in liquids, they report.

H. L. Thackwell, Grand Central vice president in charge of advanced concepts, envisions solids taking the lead in both upper stage and booster technology. Homer Joe Stewart, head of NASA Office of Program Planning and Evaluation, has concluded that if staging ratios could be optimized it would be possible to put a pound of payload in orbit for 50 lb. of propellant rather than for 800 lb. of propellant as in current rockets.

Staging Concept

Thackwell's studies of optimum staging ratios indicate that the traditional pyramidal staging should be abandoned. The pyramidal staging concept was based on the idea that each stage should add an equal increment to the velocity of the payload. Therefore, bottom stages carrying much heavier loads had to be much larger than upper stages. Thackwell and his experts here believe this theory is incorrect because rocket efficiency improves with altitude through decreasing ambient pressure. In space, specific impulse is independent of chamber pressure since ambient pressure is zero and any chamber pressure produces an infinite chamber-to-ambient pressure ratio.

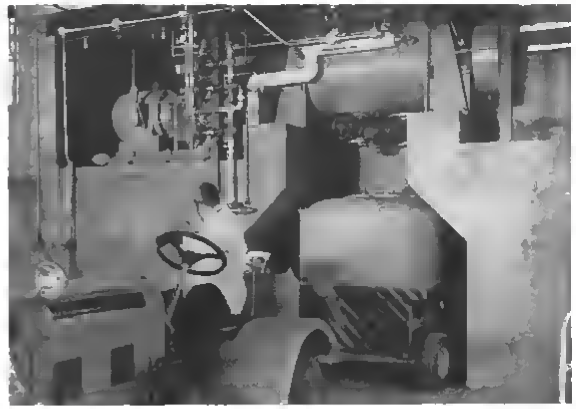
Chamber Pressures

This means that solid propellant rockets can be designed to operate at very low chamber pressure and enables the designer to use a lightweight motor case to obtain very high mass ratios without penalizing specific impulse. It indicates to Grand Central engineers that the size and velocity increments of upper stages should be increased at the expense of booster size and velocity increment for the same mission.

The potential mass ratio advantage of upper stages over boosters is not visible in current multi-stage solid propellant rockets. Mass ratio of boosters actually is better than that of current upper stages. Thackwell says this is not a meaningful advantage because a greater development effort has been expended upon the big boosters which has given them the advantage of a later state of the art.

Typical is Allegany Ballistic Laboratory's ABL-248 solid propellant top stage for Thor-Able which is almost three years old. Grand Central experts are convinced that with optimum staging ratios and improved propellant mass fractions, 50 to 1 weight-payload ratios

LARGE SOLID ROCKET ENGINE is static tested at Grand Central Rocket Co.'s Beaumont test site. Test bays can accommodate rocket engines of more than 1 million lb. thrust.



MIXED PROPELLANT is transferred (above) under vacuum to a mobile kettle from which it will be cast into a large rocket case at Grand Central's Redlands facility. Solid propellant mixer (below) has 350 gal. capacity. Blades are stainless steel.

can be exceeded with current materials and propellants. A good propellant mass fraction for present high performance rockets is around .90. Grand Central engineers expect to prove the ability to exceed .95 by the middle of this year. They are looking forward to mass fractions of .975.

Grand Central is conducting feasibility studies of high mass ratio upper stages under NASA contract. Much of the effort is devoted to reducing the weight of inert insulation which constitutes about 10% of the inert weight of modern high performance motors. Thackwell believes insulation weight can be reduced by a factor of at least 4. Promising approaches to this goal make use of radical grain configurations and flow patterns. Several new nozzle designs also look like fruitful ways to improve mass ratio.

The most important current business at Grand Central is the design and manufacture of sustainer motors and canard control units for Western Electric's Nike Zeus, manufacture of highly reliable escape rockets for Project Mercury under subcontract to McDonnell Aircraft Co., and small off-the-shelf sounding rockets. Now getting under way is a contract to operate Army's Kansas Ordnance plant at which solid propellant rockets will be produced. Hiring of a civilian operating contractor is a departure from the Army's long-established arsenal concept.

Advance Propellants

Grand Central-Marquardt hybrid rocket program is directed toward use of advanced propellants. The combination is hypergolic and the ratio of liquid to solid is small. Distinctions between fuel and oxidizer are blurred in the Grand Central-Marquardt hybrid rocket since there is some oxidizer in the solid fuel component. Addition of the liquid oxidizer improves the mixture ratio and speeds up the burning rate. The solid propellant grain is composed of CBAN binder with a heavy loading of metal additives. Liquid component has been chosen for maximum density. A fluorine base liquid would be satisfactory for this purpose.

The fuel rich solid propellant is relatively inert without the liquid component. The problem of providing good physical characteristics for a solid propellant becomes much simpler if the oxidizer can be eliminated from it or reduced.

Grand Central and Marquardt have fired experimental liquid-solid hybrids and demonstrated throttlability between 100% and 20% of maximum thrust. A key problem still is the injection of the liquid component in such a way as to get even burning of the solid grain. A possible concept might be an old-fashioned end-burning solid grain

with liquid propellant lines of combustible plastic embedded in solid grain.

The liquid propellant line might be coiled within the propellant to provide dispersion of the liquid propellant across the burning face of the solid. This raises a pair of obvious problems, the possibility of unstable combustion and the rotary impulse created by pumping fluid through a helical line. Neither of these is insolvable. The latter might be solved by installing both right hand and left hand helices. Some variation of this technique is likely to be used.

A large percentage of the applications for hybrid rockets seen by Grand Central involve manned space flight. The high degree of throttlability would be very useful on missions requiring a soft landing or rendezvous in space. Like liquid propellant rockets, a hybrid would allow pre-liftoff thrust check before committing the manned space vehicle to a launch. This is an obvious safety factor. Other applications may be found in improvements of existing solid propellant missiles whose shape and size is fixed by that of existing launchers. Good specific impulse of a hybrid could improve performance without altering geometry.

Propellant Improvement

Propellant improvement is a high priority aim for all solid rocket companies and Grand Central is no exception. Specific impulse of solid propellant rockets has been held down by the impossibility of getting an ideal oxidizer-fuel mixture ratio, without sacrificing the rubber-like physical properties so necessary in a solid propellant grain.

With conventional ingredients, an ideal performance mixture would include about 88% combustible solids and 12% of a good rubber binder like polybutadiene. This would deliver a specific impulse of nearly 260 sec. In existing rockets, 240 sec is considered a good specific impulse. The difference results from the impossibility of getting an 88-12% mixture without producing an unacceptably large number of free spaces in which there is no binder. Even an 80-20% mixture has less than ideal physical properties because of binder shortages.

If it was possible to nitrate a rubber binder, good physical properties and good performance could both be had at mixture ratios as low as 65-35%. Every important solid propellant research group in the industry is seeking this goal. One interesting approach is an attempt at artificial synthesis in large volume of nitropolyurethane being made by Aerojet.

Investigators at Grand Central have noted that as progress is made with nitrated rubbers, they become progressively more like nitrocellulose. On the

basis of this clue Grand Central is taking the reverse approach, starting with nitrocellulose and attempting to incorporate the physical properties of rubber

Nitrasol is the coined name given the new binder It is an old form chemically, but new physical properties are obtained by the use of two new plasticizers The fibrous character of nitrocellulose is eliminated, permitting it to be plasticized into a good rubber with high density, viscosity and purity A 60-40% ratio of solids to binder appears to be the ideal loading with Nitrasol However, actual loading ratio will probably run somewhat lower for easier processing and better physical properties

Nitrasol is actually a 4-base propellant No nitroglycerine is used as in one of the new nitrated rubbers This is a production asset because nitroglycerine has undesirable physiological effects It causes headaches by dilating blood vessels and lowering blood pressure Nitrasol plasticizers were chosen as much for the absence of physiological penalties as for any other reason

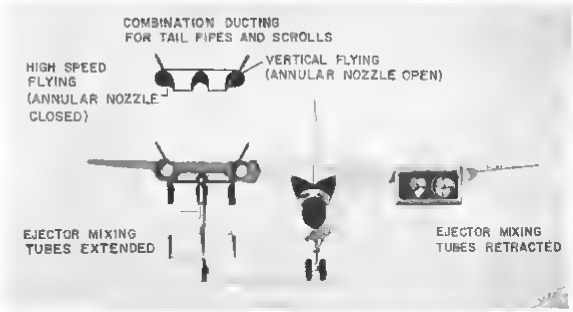
However, Nitrasol has its own manufacturing problems to be solved Of the two plasticizers used in the manufacture of Nitrasol, one is a relatively low energy, stable material but the other is a high energy material and extremely explosive Interstate Commerce Commission requires dilution of the high energy plasticizer for shipment The dilutant must be distilled out before the propellant is mixed

The distilled plasticizer requires careful handling until it is mixed with the other ingredients The high quality nitrocotton which is the main ingredient of the binder is also difficult to handle before mixing because of its dry, dusty condition and the high level of fire hazard

Good Properties

The high energy plasticizer provides good physical properties at high temperatures and the low energy one improves low temperature properties, especially rubberiness Nitrocotton and the high energy plasticizer are somewhat stabilized in combination

Grand Central officials report that the industry has had explosions with nitrated rubber binders Grand Central has had none as yet with Nitrasol, but company engineers act on the assumption that Nitrasol will detonate too given the appropriate circumstances For this reason, confinement is avoided in manufacture of Nitrasol and mixed batches are limited to 220 lb. Total mixing time for a batch this size is about 20 min which enables an acceptable production rate to be sustained Machinery used is cheap enough to allow concurrent production at sites



Hiller Studies Transonic Design, Modifies Platform

Transonic vertical takeoff aircraft (above) proposed by Hiller Aircraft Corp would use jet engine thrust to entrain ambient air to increase total thrust for vertical lift Hiller is building an experimental "annular ejector" jet propulsion system under an Office of Naval Research contract Hiller has modified its VZ-1E Flying Platform (below) The larger, higher-speed propeller version has conventional controls

dispersed for safety Nitrasol is mixed in open polyethylene tubs so accidental burning will not cause catastrophic detonations A tub costs about $25 The mixer is a rotating paddle on a vertical shaft driven by a pneumatic motor costing about $400 Total investment in a "bread dough" mixer for conventional propellants is about $100,000

Cheaper mixer can be used because Nitrasol is less viscous before curing than current solid propellants Low viscosity is due in part to lower percentage of solids used Nitrasol will have conventional oxidizers notably ammonium perchlorate which has the advantage of low temperature dependence low cost and low water solubility Temperature independence is an important factor Many other oxidizers burn more rapidly as temperature increases and various salts must be added to combat this tendency The proportion of powdered aluminum additive in Nitrasol is about the same as in earlier solid propellants Metal additives usually constitute about 15% of non-binder material

Low Cost Mixer

A simple, low cost mixer that could be used for Nitrasol was discovered accidentally At first, it was assumed that costly bread dough mixers would have to be used as with any other propellant Priority of Nitrasol was too low early in the program to warrant the assignment of much time in the mixers Because of the unavailability of regular mixers, a laboratory chemist at Grand Central, began trying to make the material with a conventional laboratory stirrer When it was found that he could turn out consistently high quality Nitrasol with this simple equipment, production scale mixers were patterned along the same lines

Pot Life

An important advantage of Nitrasol is its good pot life in the uncured state. It can be kept for as long as a week at 70F if necessary Binders now in use have a pot life measured in hours This would seem to make Nitrasol a good material for continuous mix or on-site casting of propellants Grand Central has not yet instituted a continuous mix Nitrasol program To date, the firm's continuous mixing work has been with nitrile propellants. Nitrasol is probably being studied as a propellant for Nike Zeus It has yet to be fired in a motor that large, but the program is partially funded by Douglas Aircraft Co., Nike Zeus airframe contractor

Sequence of events in manufacture of Nitrasol is:

- **Mix** the four stabilizers and plasticizers needed in a single tank. This can now be stored in polyethylene bottles and batch checked occasionally for months or even years
- **Add nitrocotton** to the other ingredients and mix to a smooth thin paste or slurry This eliminates the hazard features of nitrocellulose, making it physically and chemically quite stable The mixing process can be stopped at any point and the slurry can be quality checked
- **Add the aluminum powder.** The slurry now is stable and solids in it are well suspended From the start of mixing until this point the degree of hazard is very low
- **Add the ammonium** perchlorate or other oxidizer When this has been done, a fire hazard exists and a water deluge system must be available
- **De-aerate the slurry** by discharging it into an evacuated chamber through a tiny orifice or slot This must be done at least twice to eliminate all bubbles
- **Cast and cure** the propellant grain Nitrasol is cured at temperatures between 140F and 160F

Nitrasol should yield a specific impulse of about 260 Laboratory materials have achieved 272, but these have not been developed far enough to call them propellants Closer to operational use than Nitrasol is CBAN Grand Central officials decline to confirm or deny industry reports that Nike Zeus sustainers loaded with CBAN have been static fired and are nearing flight test Problems faced with CBAN include high viscosity and high oxidizer loading

Polaris A1X14 Test Vehicle Flies 900 mi.

Polaris A1X14 test vehicle launched from Atlantic Missile Range flew 900 mi carrying instrumented nose cone. Navy-Lockheed vehicle's flight control system has been modified to reduce weight and to facilitate maintenance under operational conditions

fraction. Best oxidizer proportion is set at about 77%. It is a difficult material to cast, but Grand Central believes that problem is solved. The firm expects to use a pressure casting technique in which the nitrile propellant will be forced out of the kettle, into the motor case by nitrogen under pressure.

Perhaps the most significant part of production at the Grand Central Rocket Co. Redlands plant is that devoted to developmental Nike Zeus sustainers and canard control motors and escape rockets for Project Mercury capsules. Naturally, the volume output of these jobs is small. The Nike Zeus sustainer is the largest motor turned out by Grand Central to date. Extremely high thrust to weight ratio is necessary to get the rapid acceleration called for by the antiballistic missile mission.

Douglas has developed extremely light motor cases and glass-plastic nozzles with ablative throat liners which condition much of the work done by Grand Central and Thiokol, propulsion contractor for Zeus booster. Grand Central has done some work with plastic motor cases. Experience indicates that one of the requirements which the liner must meet for such motor cases is the ability to prevent leakage of propellant through the case wall.

Liner Curing

Grand Central also is experimenting with new methods of liner curing. In conventional application of the Zeus 125 lb. liner, 12 coats are needed. Two coats can be applied each day, making a total of six days to apply and cure a single liner in a pit oven. Each curing cycle requires 12 hr. at 180F. Experimental methods are aimed at abolition of pit oven curing. One experimental method is to insert a battery of infrared lamps and cure from the inside. Engineers hope this will enable them to cure a liner completely in 12 hr.

However, simple electric heating elements inserted inside the liner appear to be working better in tests than the infrared lamps. When internal heat sources are used, Grand Central engineers apply insulating blankets to the outside of the motor case. One Grand Central scientist thinks there may be a net gain in casting a free standing propellant grain, potting it in a liner and then inserting it in the motor case, rather than applying the liner and casting the propellant grain directly in the motor.

Controls on manufacturing and specifications of the NASA Mercury escape rockets are much tighter than those on Zeus motors because of the extreme reliability demanded of a safety device for a man carrying vehicle. The reliability requirement has also demanded a sacrifice of a certain amount of efficiency in the escape rocket. Total impulse-to-

weight ratio of the escape rocket is only about 90

An extra strong extra heavy motor case of heat treated 4130 steel is used and rigorous qualification tests in vibration, temperature and steady state load extremes are applied Specific impulse of the conventional polysulfide-ammonium perchlorate propellant with aluminum additive is only about 205 This propellant was picked because of the great amount of experience piled up with it and its high degree of reliability There has never been a failure in escape rocket tests to date

Typical of the close quality control demanded by NASA is a "white glove inspection" which must be given to the internal surface of the propellant grain after a period of storage White glove inspection is to allay fear that oxidization and degassing of exposed propellant surface may delay ignition Degassing causes the propellant to discolor and turn black. The test, called for by the process specification will detect this easily The same insistence on quick ignition has led NASA to specify a very large igniter Some consideration is now being given to periodic removal of a thin of propellant from the internal surface to eliminate any barrier of deteriorated propellant

The escape rocket is capable of lifting the Mercury capsule 2,500 ft from a standing start on the launch pad Total impulse is about 57,000 lb sec Escape rocket itself before ignition weighs 650 lb Post firing weight is 350 lb Sea level nozzle with an expansion ratio of about 14 was chosen to give the escape rocket its best efficiency in the most critical emergency, escape from a disaster on the launch pad Thrust of over 50,000 lb and burning time of about 1 sec lift the capsule to an altitude of about 2,500 ft

Complex propellant grain shapes and flow patterns of advanced Grand Central motors such as NASA experimental motors complicate ignition problems To solve these, Grand Central engineers are developing a family of sheet igniters These are composed of primer cord embedded between sheets of epoxy resin in laminations of silk treated with nitrocellulose and acetone Nearly instantaneous detonation of the sheet igniter causes burning to begin quite uniformly on the exposed surfaces of the grain

Space Boosters

Grand Central is proposing solid propellant space boosters of up to 15 million lb thrust Grand Central officials say they could place a 100-million-lb sec solid propellant booster on the pad at Cape Canaveral, Fla., within three years They claim some performance benefits as well as cost advantages for solid propellants Biggest cost advantage is in ground support equipment which they say may cost nine times as much for a liquid propellant rocket as it does for a solid propellant rocket

One performance advantage claimed stems from the better thrust-to-weight ratios obtained with solid propellant rockets This yields more rapid acceleration and shortens the vertical lifting phase of flight, thereby reducing velocity loss due to gravity Grand Central engineers say increasing the thrust-to-weight ratio of liquid propellant rockets would increase the weight of turbopumps and other propulsion components so rapidly as to seriously reduce their propellant mass fractions Grand Central has thought of proposing solid propellant assist to increase the initial thrust-to-weight ratio of liquid propellant boosters Initial acceleration of large solid propellant rockets is typically 10 times that of large liquid propellant rockets

Grand Central favors segmented construction for its large solid propellant boosters Even if there were a means of transporting a 15 million lb thrust solid propellant rocket intact the explosive hazard would be prohibitive Though the probability of such a catastrophe would be extremely low, it would only have to happen once to wipe out a good sized city

Like all other solid propellant rocket makers, Grand Central has studied thoroughly the various ways in which the explosive hazard could be divided and separated The company decided in favor of thick sausage slices bonded in motor case segments at the factory Problem of how to control burning at the segment interfaces was sidestepped by eliminating the conventional asterisk-shaped charge port Big Grand Central boosters would have circular-section ports with wedge-shaped gaps at the between-segment joints The effect of this configuration is to keep burning area and chamber pressure constant during operation in the same way as the asterisk or star section ports currently used Extra insulation would be needed at the case joints

A promising venture for Grand Central is its contract from Army to operate the Kansas Ordnance Plant at Parsons, Kan The plant now on standby status, will be converted from the manufacture of munitions to the building of solid propellant rockets Architectural and engineering phase of the conversion is to be completed by Nov. 1 and the plant could be in production by August, 1962 No rockets will be made there with propellant weight under 5 000 lb Both stages of Nike Zeus might be built there if the Army missile reaches production

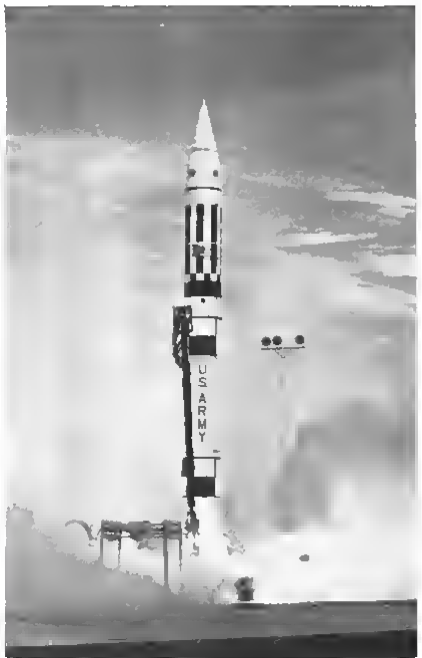
Conversion of the plant will cost about $5 million up to the time limited production begins, but by the time operations get into full swing in 1963 investment in the conversion will amount to about $20 million Total value of the plant should reach about $180 million. The plant has five production lines Three of these will be modified and new mix stations, cobalt radiographic facility and casting and curing buildings will be set up Some rocket development work will be conducted there, but it will be mainly in the area of product improvement and production design No original missile design work is expected The Army has traditionally done its own production

Southwestern Industrial To Build Space Components

Contracts totaling $488,780 have been awarded Southwestern Industrial Electronics Co., Houston, Tex., for space vehicle and missile electronic components Army Ballistic Missile Agency awarded SIE an initial $212,370 contract covering d-c amplifiers to be used on Saturn, Martin-Orlando awarded a $236,408 contract for Titan D8 A amplifiers, DL-12 phase sensitive demodulators, FMC-1 flowmeter converters, TPC 5 and TPC 27 power supplies Equipment to be used in power supply systems in Polaris was subject of a $40,000 contract from General Electric.

Army Pershing Tactical Missile Flies 30 mi. on First Firing

Army Martin Pershing test vehicle was fired about 30 mi. down the Atlantic Missile Range in its first flight late last month (AW Feb. 29, p. 34; Mar. 14, p. 87). Solid propellant test vehicle carried a dummy second stage and flew on a programed unguided ballistic trajectory. Army and Martin will test a variety of first stage sizes and shapes before setting the final Pershing configuration.

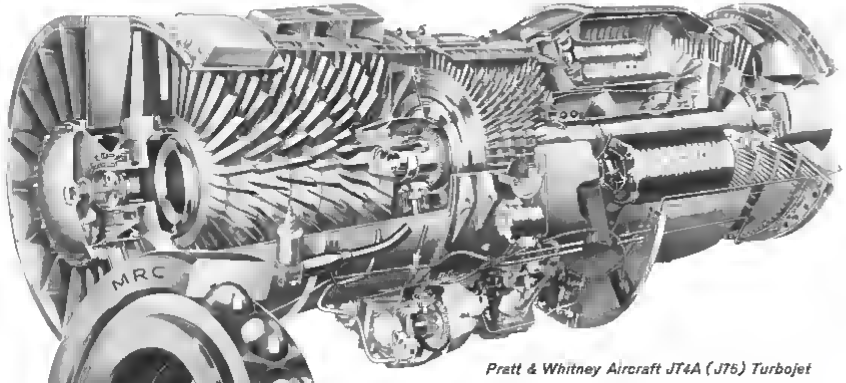


MARLIN-ROCKWELL

RELIABILITY

COUNTS

IN THE AIR



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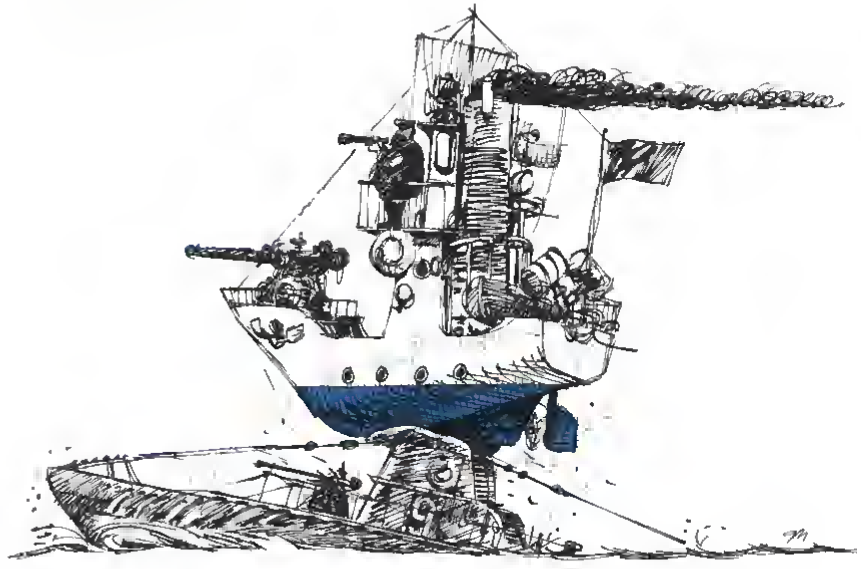

underwater detection problems?

A vital link in this country's defense chain is a reliable, accurate Anti-Submarine Warfare program to provide advance warning of the presence of a potentially hostile submarine Hoffman has contributed substantially to this program through the manufacture for the U.S. Navy of Sonobuoys to detect and locate undersea objects In addition, Hoffman has broad experience in underwater simulators, as well as communication links and navigation aids for ASW aircraft This background provides Hoffman with a capability-in-depth to help solve your problems in underwater detection

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Hybrid Telemetry Proposed for Future Use

By Philip J. Klass

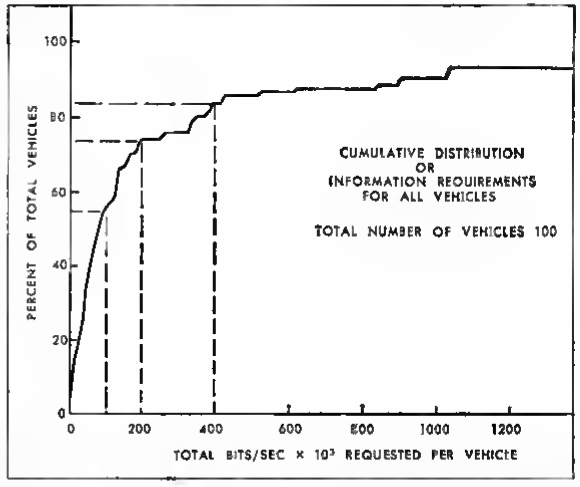
New York—New type telemetry system, which may become the military/industry standard for general purpose use, was revealed here during the recent Institute of Radio Engineers convention.

New system is a hybrid analog digital time division multiplex type which employs both pulse amplitude modulation (PAM) and pulse code modulation (PCM) techniques, using frequency modulation of the RF carrier. It is designated PACM-FM.

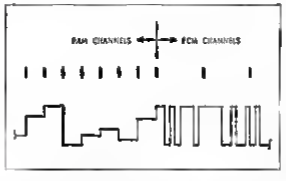
The proposed system is the result of a three-year investigation by Aeronutronic Division of Ford Motor Co. under tri-service sponsorship. Program was monitored by Army Signal Corps. Program objectives included a survey of all major telemetry users, a forecast of future requirements and a determination of the type of telemetry system which could best meet these needs.

The hybrid PACM FM system concept recently was presented to the tri-service telemetry steering committee and the Inter-Range Instrumentation Group (IRIG) which coordinates telemetry activities of all major military test facilities. First public report was made here during the IRE convention by W. F. Link and M. B. Rudin of Aeronutronic Company's final report, with full technical details, is expected to become available soon through the Commerce Department's Office of Technical Services and through Armed Services Technical Information Agency.

Aeronutronic's survey of major telemetry users revealed the need for great flexibility in any future telemetry system. For example, the survey indicated an "average user requirement" for handling data from about 75 sensors with an equivalent total data rate of 75,000 bits per second. But large aircraft and missile manufacturers indicated a need for a system to handle up to 400 sensors, and nearly 10% of those surveyed requested data rates of more than one million bits per second.



NEW HYBRID pulse amplitude-pulse code modulation (PACM) telemetry system, which may become a future standard, is the result of a three year investigation by Aeronutronic under tri service sponsorship to determine future needs of telemetry users and the best technique for meeting them. Results of Aeronutronic survey of missile and aircraft builders, shown above, indicate data capacity needed as a function of percentage of total vehicles.



NEW HYBRID PACM system employs pulse amplitude modulation for low-accuracy data with pulse code modulation for information that requires high accuracy.

Required Accuracy

The telemetry accuracies required by users ranged from as high as 0.1% to as low as 20%. But because only a small fraction of the total data must be transmitted with such extreme accuracies, it would be grossly inefficient to design the entire system for such accuracy, Link pointed out.

Aeronutronic scientists analyzed and tested the four most promising modulation techniques now available: pulse amplitude modulation (PAM-FM), pulse code modulation (PCM-FM), pulse duration modulation (PDM-FM) and the long-used MF-FM. Factors considered in this analysis included data capacity, accuracy, spectrum and power requirements, size and weight of equipment and compatibility with existing test range facilities. Rudin reported that the analysis indicated the following results:

- **Pulse amplitude modulation** (PAM-FM) appeared to make most efficient use of power and spectrum for medium accuracy transmission where an error of ±2% or greater is acceptable.
- **Pulse code modulation** (PCM-FM) appeared superior in performance for high accuracy data transmission where errors of 0.5% or less are required.

Pulse amplitude modulation is an analog type of modulation in which the value of the output voltage from the sensor is transmitted periodically, instead of continuously as in FM-FM, in the form of a pulse whose amplitude is a function of the amplitude of the sensor output voltage. Pulse code modulation is a digital type modulation in which the sensor output voltage is converted into a binary code and transmitted as a series of pulses. With PCM, almost any degree of accuracy can be obtained in exchange for fewer data channels.

Because each of these two modulation techniques has certain advantages not enjoyed by the other, and because the two are in no way incompatible,

Infrared Scanner Has ICBM Defense Application

Infrared scanner for operation in the far infrared portion of the spectrum (10 to 100 microns), has been developed by Martin Co. for possible application to ICBM defense or space vehicle guidance. The gyro-stabilized infrared scanner, which weighs 50 lb. in model shown by I. E. Distelhurst project engineer employs a 12-in. aperture, highly sensitive supercooled detectors and extremely low noise amplifiers. This enables device to distinguish between objects with small differences in temperature at 'distances in excess of the known current state of the art,' according to Martin

Aeronutronic scientists propose to combine them into a hybrid PACM-FM system which offers the best features of each. The resulting system Link said should be able to provide the versatility and flexibility needed by a variety of telemetry users during the next decade, or longer.

Each train of pulses transmitted will consist of a sequence of amplitude modulated pulses followed by a series of binary coded pulses. The proportion of the total train used for each type will be left to the discretion of the individual user as required for his particular telemetry problem.

If a specific telemetry task doesn't require any data with accuracy better than 1%, the new system can be operated as a pure PAM type. If all data channels must provide extremely accurate data, the entire pulse train can use PCM modulation.

The airborne equipment required for the new PACM-FM system would differ only slightly from that now in use for PCM-FM Link said. A gating device would be needed to bypass the PCM encoder to admit PAM samples or for digital input signals. Also the airborne multiplexer would need to be controlled by a programmer because PAM samples appear at a faster rate than PCM samples Link noted.

Despite these several additions, Link predicted that for most applications the hybrid PACM-FM system airborne equipment would be smaller and lighter than a pure PAM or PCM design.

The PACM-FM ground station equipment also differs only slightly from that now required for PCM and PAM telemetry systems, and it would be less expensive than maintaining separate PCM and PAM ground stations, Link said.

Initially the PACM-FM system probably would provide for only two accuracy levels, one from pulse amplitude modulation and one from pulse code modulation, but the system always can be modified if desired, to provide for several different PAM pulse lengths and several different PCM word lengths to give additional levels of telemetering accuracies.

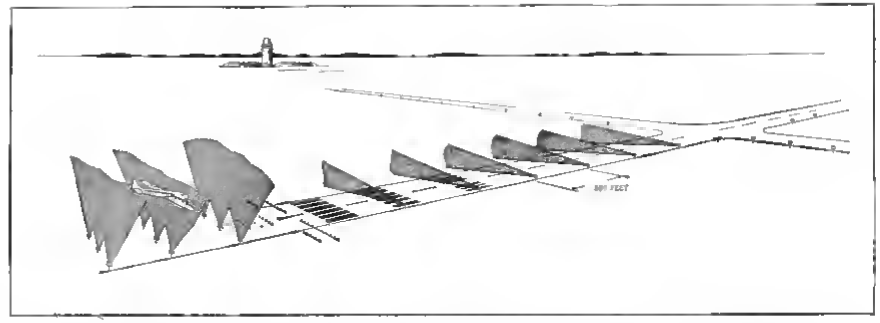
Aeronutronic's analysis of the new hybrid system compared with a pure PAM or PCM telemetry system, indicates the following advantages for the PACM-FM system:

- **Accuracy:** Provides greater range of accuracies with maximum efficiency.
- **Bandwidth:** Equal to or less than either PAM or PCM.
- **Sensitivity:** Threshold power is equal to or less than PAM or PCM for same task.
- **Frequency response:** Matches PAM or PCM, using subcommutation or super commutation to obtain desired sampling rate and data accuracy.
- **Flexibility:** Combines analog and digital data in optimum format to suit data characteristics.
- **Compatibility:** Adapted to both analog and digital inputs of varied accuracy and to analog and digital ground station equipment.
- **RF spectrum conservation:** Optimum combination of PAM and PCM to minimize spectrum used.
- **Complexity:** Comparable to that of multiple-accuracy PCM when both PAM and PCM data is handled, or to a PAM or PCM system when only PAM or PCM data is handled.
- **Rate of obsolescence:** Should satisfy all user requirements predicted for next decade.
- **Experience:** Utilizes techniques common to both PAM and PCM.
- **Cost:** Less than for multiplicity of less flexible telemetry systems required to perform same tasks.

Copies of Aeronutronic's final report summarizing the results of its three-year investigation have been transmitted to interested technical societies with the request that they submit their comments by June 30 to the Telemetry Working Group of the Inter-Range Instrumentation Group. Later this summer the Telemetry Working Group expects to meet with Aerospace Industries Assn.'s Aircraft Flight Test Radio Coordinating Council, which represents major aircraft/missile manufacturers to discuss the proposed new PACM-FM system and its future implementation.

Barring sharp objections to the proposed new system, IRIG's Telemetry Working Group is expected to revise its recently prepared Pulse Code Modulation Telemetry Standards to encompass the hybrid PACM-FM system. This in turn must be approved by the parent IRIG when it meets later in the year. These standards will spell out system signal characteristics rather than attempt to define PACM equipment design specifications.

Because both government and industry now have a very sizable investment in FM-FM telemetry equipment, it is expected that the switch to PACM, if adopted will be on a gradual transition basis and that FM-FM will continue to find at least limited use.



DOPPLER detectors will beam microwave energy across runways and taxiways to detect presence of surface traffic while similar detectors in the approach zone will be directed upward to catch aircraft at altitudes up to 400 ft. Doppler detector system designed and delivered by Airborne Instruments Laboratory to Federal Aviation Agency is one of two techniques to be evaluated

Doppler, Loop Tested for Runway Control

By Barry Miller

Atlantic City, N. J.—Tests of an experimental program for controlling traffic on airport runways and taxi strips are slated to get under way here this month.

The program, known as Taxiing and Routing of Aircraft Coordination Equipment (TRACE), is a research and development effort conducted by the Federal Aviation Agency's Bureau of Research and Development (AW Jan. 5, 1959, p. 28). From it, an efficient and safe method of routing aircraft, and perhaps other vehicles, between loading gates and active runways is expected to evolve.

Such a system is needed, it is believed, to properly regulate growing traffic on existing airport surfaces.

Basic objectives of the TRACE program are to investigate the feasibility and design of a system that would:

- **Detect the presence** of aircraft and other vehicles on selected portions of runways, extending into the approach zones, and taxiways.
- **Display direction of travel,** identity and other pertinent data on each aircraft in prescribed areas to the airport controller.
- **Determine the action** or direction necessary to obtain safe and expeditious flow of traffic.
- **Display the necessary signals** on the airport to direct traffic flow in a desired manner.

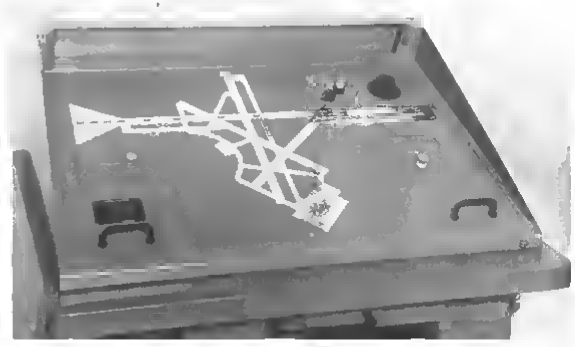
TRACE has progressed to the point where the necessary detection devices along with displays for the location and direction of aircraft and vehicle travel have been delivered and are almost completely installed and made ready for evaluation at the FAA's National Aviation Facilities Experimental Center here.

As part of TRACE, information similar to that provided by Airport Surface Detection Equipment (ASDE) will be displayed. The two will differ in that ASDE information cannot be used for automatic control of visual guidance aids for the pilot whereas TRACE information will be, according to Al Hopkins, Jr., of FAA.

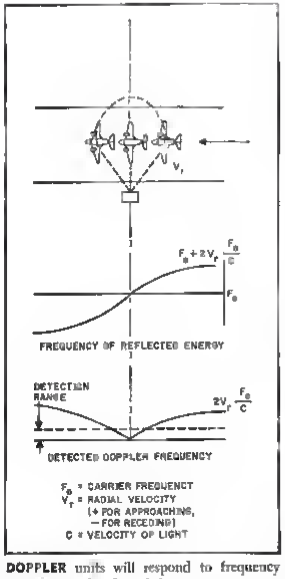
Two Techniques

Two basically different techniques for detecting the passage of an aircraft on taxiways and runways are to be examined under TRACE. One of these utilizes a magnetic induction loop buried in the concrete surface of the runway. The other is the doppler detection technique. While these two sensing techniques roughly parallel one another in function, doppler detection may be employed in the approach zone, as well as on the surface, to detect the presence of aircraft before touchdown, so that the two could be regarded as complementary techniques.

The magnetic induction loop system, including sensing loops, electronic gear, cabling and tower displays were supplied to the FAA by General Railway Signal Co., Rochester, and its subcontractor, Radio Corp. of America. Equipment for the doppler sensing technique, regarded as a subordinate effort, was prepared by Airborne Instruments Laboratory, Inc., Deer Park, N. Y.,



DISPLAY panel with scaled overlay of Atlantic City Airport will be used in conjunction with doppler detection techniques. Lighted arrows embedded in the scaled runways indicate presence and movement direction of an aircraft in the system



DOPPLER units will respond to frequency shift in signal reflected from moving target which goes to zero when target is directly opposite from the unit.

with the aid of Automatic Signal Division of Eastern Industries in Norwalk, Conn

In the induction loop method, as FAA's Hopkins explains it, the loop is tuned and a small amount of RF energy circulated in it A vehicle, crossing over the loop, will have eddy currents induced in it These currents will then disturb the loop's magnetic field

Loop Detueing

Detuning of the loop is detected in a sensor box located alongside the runway, a relay, which operates the control tower display, is tripped Directional information, Hopkins points out, is obtained when adjacent loops sequentially indicate presence of a vehicle Thus, as an aircraft passes over one loop, an indicator in the control tower display turns red When the aircraft crosses the next loop the original indicator light is canceled, the next one lights up

The loops in the runways, Hopkins says, will be about 100 ft long and 10 ft wide Installation of the loop wires was completed last fall About 10,000 ft of runway and 20,000 ft of taxiways are being equipped here Most of the equipment is presently installed and the loops will soon be tuned

This induction loop sensing technique is based on a phase shift produced in the tuned loop A sensor box embedded in the ground a few feet away from the runway translates phase shift changes into relay operation and electrical notice to the tower display

RCA is responsible for the sensing loops and associated gear, and General Railway has charge of system planning, tower display, cable plans and the relay networks

To distinguish between the phase shift produced by weather changes which exceed those due to passage of a vehicle, the system responds to the rate of change of phase shift thus accommodating itself to rapid changes caused by aircraft and ignoring the slower weather changes The technique has successfully detected small aircraft, moving only at about 3 mph, Hopkins says At the same time, the most rapid anticipated weather changes will not trip the relays

Doppler Detection

Airborne Instruments' doppler detection system has its own displays as well as the small radio devices, operating in S band (2 455 mc) which beam energy across the runway and detect the doppler energy shifts reflected from moving targets Detectors are located at fixed intervals, perhaps 500 ft apart along the runway, and the area covered by each is referred to as its block As in the induction loop method, detection of an aircraft in a given block actuates a relay which will generate a display

The doppler system being installed now at Atlantic City is a limited installation, covering only a portion of the airport and involving about 20 or 22 dopplers, according to Joe Woodward, section head in the Aviation Systems Research Department at Airborne Instruments TRACE is only an experimental program he points out and a sample of the system should be sufficient for evaluation, especially because the doppler detectors are portable and will permit simulation of different situations

Besides the dopplers installed along the runways and taxiways, three lines of detectors are to be located in the approach zone extending out to the middle marker at about 3,500 ft., to pick up aircraft in the final approach Detecting aircraft in approach at altitudes up to 400 ft is a key feature of the doppler sensing technique, Woodward says It will warn of an impending aircraft landing, something the magnetic induction loop does not do Information supplied by these approach dopplers can be entered into traffic routing and scheduling equipment to determine the best taxi routing and to assure safety on a live runway that the aircraft will subsequently occupy

Similarly, detectors located at the edge of the runway can pick up targets not in actual contact with the runway but up to 50 ft. above it This will guarantee inputs to the system, Woodward says, in case the aircraft "floats" down the runway before landing or in cases of a last minute wave-off

Other Advantages

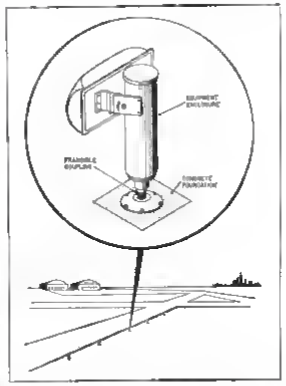
In addition to detecting aircraft on the approach, Woodward believes the doppler sensing technique offers these advantages

- **Installation without disrupting** an airport's normal operating conditions.
- **Ease of maintenance.**

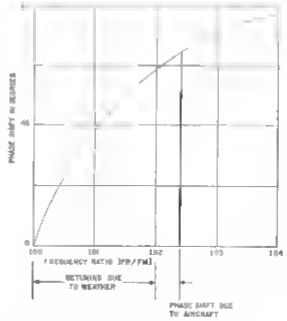
It is, however, more subject to triggering by spurious targets, such as birds, than the induction loop method, he concedes

The doppler units for this system are adaptations of units developed for vehicular traffic control systems by Automatic Signal Division Individual units are 30 in in height and can be installed at about the same relative position as a runway marker light The dopplers are mounted on frangible couplings so that they can break off at the stem if struck by a plane's landing gear. The approach unit is larger, primarily because of the need for a larger antenna, Woodward says

Since only the radial component of target movement produces doppler shift, the shift goes to zero when the target is opposite one of the units Circuits in the units will accept only the low frequencies as the doppler shift approaches and departs for zero, Woodward reports For the S band carrier frequency of the doppler units, a radial



RUNWAY doppler radar is about 38 in high and can be installed at about same relative position as runway marker light



DETUNING of magnetic induction loop caused by aircraft and weather

velocity of one knot produces a shift of about 3 cps By restricting the audio bandwidth of the detectors to frequencies below about 150 cps Airborne Instruments engineers have made the detectors sensitive to the desired doppler signals but insensitive to most sources of interference, including interaction between units, Woodward reports

When a vehicle is detected, the unit actuates a relay which signals the presence of a vehicle in its block back to the display Logic circuitry in the display system will indicate the travel direction and block position For example, as an aircraft passes the first boundary detector in the approach zone the relay is tripped and the fact recorded in the central logic circuit When the aircraft passes the second boundary the logic circuit knows it is in the second block and consequently its direction is established An arrow light in the display, located in the appropriate point of an overlay replica of the airport runways and taxiways, is lighted to show block occupancy and direction of travel This sequence lighting with arrows continues to spot the block in which the aircraft is located, and continues indefinitely as the aircraft lands and enters the taxiway system

Display Features

Other features of the Airborne Instruments display include

- **Time-delay circuit** which flashes the directional arrow if the adjacent boundary is not passed in a prescribed time
- **Bi-directional arrow flashing** if a target crosses the runway boundary without having entered at the approach end,
- **Runway monitor** which can alert the operator to the presence of an aircraft crossing the taxiway into the last runway boundary while another aircraft is in the approach zone or on the runway

Airborne Instruments and Automatic Signal jointly tested the doppler units with the FAA at Newark, La Guardia, Atlantic City, MacArthur and Pocono airports before they were installed at NAFEC Individual runs with different types of aircraft from Piper Tri-Pacers to jet interceptors as well as helicopters, showed that aircraft can be detected in the approach zone, on or above the surface of a live runway or along the taxiways

Not only its velocity of travel, but the large rotating blades of helicopters were extremely productive of doppler signals Some 200 to 300 analyzed flight samples provided corrections of preliminary design principles according to Woodward

Flight tests and evaluation at NAFEC should determine the optimum spacing between blocks in the approach zone, the live runway, taxiway and at intersections and demonstrate the performance of both systems with various types of aircraft under different weather conditions

Reducing Workload

One objective of TRACE, according to Al Hopkins at FAA, is to cut radio telephone needs thus relieving frequency channels and reducing the workload of the controller A future part of TRACE may call for a system of signal lights, located at convenient points along the runways to furnish the controller with a manual means of guiding the pilot Eventually this manual operation could be replaced by an automatic sequence Or guidance might be furnished by a small display in the cockpit, although this is not anticipated because any type of plane is expected to be accommodated on a non-cooperative basis

The equipment to be evaluated now, however, does not include any special means of signaling pilots so that radiotelephone presumably will be used

With adaptation ultrasonic detectors now made by General Railway for overhead control of vehicular traffic in parking lots might be employed like dopplers as cross runway sensors, a company spokesman says

Ultrasonic and doppler detectors may be comparable in size cost ease of maintenance and installation, according to the firm

The magnetic loop detection technique might be economically employed at small airports which have intersecting runways with the intersections located at some distance from the controller A loop would be embedded in each runway before and after the intersection The display—a simple cross with four lights each one corresponding to one of the four loops—would give the controller a quick indication of traffic at the intersection.

PRODUCTION order is fed into operations control transmitter by Frank Eskiow, Norair manufacturing control dispatcher. Order replaces several reports prepared manually

Automated Production Control To Reduce Man Hours, Paperwork

Hawthorne, Calif—Northrop Corp.'s Norair Division is installing a system which will automatically process more than 45,000 production orders daily to control costs, meet schedules and deliver finished parts.

Scheduled for operation this month, Norair's Automated Operations Control system will utilize Friden Corp.'s Collectadata units placed throughout the division's manufacturing area to feed data to an IBM 704 computer in the Computing and Datamation Center. Eliminating many clerical functions of shopworkers and foremen, the system will automatically produce reports on production, performance and labor, and ensure control over location and movement of production orders.

Information will be electronically relayed by 97 transmitter units to a central receiving unit, which automatically transfers the information to paper tape. The paper tape is transferred to the Computing and Datamation Center which converts the information to punched cards and then to magnetic tape. Magnetic tape is then fed to an IBM 704 computer which processes the data and relays the results back to magnetic tape. Tape is then fed to a high-speed printer to produce the desired report.

Each transmitter in the manufacturing area automatically reports its station, serial number of the production order, sign-in and sign-out of the employe, and the number of the employe assigned to the order. Receivers are equipped with an automatic lockout system that prevents a transmitter from starting simultaneously with another or breaking in while another is operating. An automatic time code emitter records time of each transmittal.

The control system produces zone shortage and aging reports daily and production order status, shop loading, labor, shortage and sales order closeout reports weekly. Elimination of the clerical functions of shopworkers will save more than 425 man hours daily.

SAC Has World-Wide Air-Ground Voice Link

Dallas, Tex.—Short Order, a high frequency single sideband system providing positive direct voice communication between Strategic Air Command bases and its airborne aircraft anywhere in the world, was formally inaugurated at Offutt AFB, Omaha, Neb., recently by SAC Vice Commander Lt. Gen. Frances H. Griswold.

Two Short Order sites, one at Offutt and one at Barksdale A.F.B. Shreveport, La., are activated. Two others, one at Westover AFB, Mass., and March AFB, Calif., are being built. Any one of the sites is designed as a wholly independent operation permitting instantaneous communication anywhere in the world.

Basically, each site comprises a 172-ft. Wullenweber antenna measuring 500 ft. across the center, plus 15 single sideband transmitter and receiver antennas, which increase the SAC ground-to-air communications system from 500 watts to 45,000 watt capacity. Short Order provides air to ground communications for inflight emergencies.

The system was engineered and installed by Alpha Corp., Dallas, with equipment manufactured by Collins Radio Co., Dallas, and Cedar Rapids, Iowa. Alpha is Collins system management subsidiary.

Short Order was authorized by USAF two years ago. Although Alpha declined to comment on the contract amount, indications are that cost of the system is just over $8 million.

FILTER CENTER

▶**Paramp Tracks Pioneer V**—National Aeronautics and Space Administration operated a beam parametric amplifier, made by Zenith Corp., in conjunction with 16-ft. dish at Blossom Point, Md., in tracking the Pioneer V Venus probe. Successful field tests of another Zenith paramp in an L-band radar at Rome Air Development Center were reported recently (AW Mar. 21, p. 73).

▶**Researching Cryo Bolometer**—Investigation of a superconducting bolometer (AW Mar. 28, p. 72) capable of responding to very low RF fields, is under way at Franklin Institute in Phila.

The following Filter Center items are compiled from reports and informal discussions at the 1960 Institute of Radio Engineers International Convention held in New York City.

▶**Tattooed Transducers**—To relieve discomfort caused by probes inserted under the skin of a man in space, scientists may tattoo transducers and amplifiers onto the skin of a human to aid ground stations in monitoring human responses in space flight, according to T. C. Helvey, Radiation Inc.

▶**Signal Corps Research**—In reviewing component research and development at the U. S. Army Signal Research and Development Laboratory, Col. L. J. D. Rouge mentioned these items of interest at the Ft. Monmouth Laboratory:

- **Missile Maser** (ammonia beam), about 14 in. high and capable of operating for more than 8 hr. in sealed-off condition, which has been tested under static accelerations up to 30g with a resulting frequency deviation of less than 3 parts in 10^{10}.
- **Cesium beam frequency standard,** with deviations of one part in 10^{10}. These clocks may be used as part of Project WOSAC (World Wide Synchronization of Atomic Clocks), a study of the feasibility of a universal time standard, which could be used in missile tracking and guidance.
- **Solar cells,** p-type silicon diffused with phosphorous, with efficiencies consistently greater than 12%.
- **High frequency transistors,** operating at 6,000 mc. and power transistors capable of 3 watts at 70 mc. A 10 watt transistor at 100 mc. is expected this year.

▶**Molecular Computer Confirmed**—Report that Texas Instruments is under contract from the Air Force to deliver an airborne digital computer using molecular electronic techniques throughout (AW Feb. 8, p. 79) was confirmed by Col. William S. Heavner, Wright Patterson AFB in a talk at the IRE Convention. Completely molecularized computer is expected in 1961, Col. Heavner said.

▶**More Micromin Programs Coming**—Another cluster of firms is expected to introduce microminiaturization programs sometime this year. Among the new entrants will be Thompson Ramo Wooldridge and ITT Laboratories.

▶**Solid-Circuits Available**—Solid Circuits, semiconductors which perform complete circuit functions (AW Mar. 30, 1958, p. 33) are offered commercially by Texas Instruments, Inc. Nearly a dozen different types of circuits have been produced for various applications, the most widely used types being the first to be made available. Among circuits already produced by TI are audio amplifiers, inverters, oscillators, filters, "and" and "or" gates, "nor" circuits, multivibrators, shift registers, and binary counters. Full adder reportedly costing near $18,000, was made for

Arma Division, American Bosch Arma Corp.

▶ **Microminiaturized Component Whispers**—Among the microminiaturized components which were not openly displayed at the IRE Show but which were discussed privately among manufacturers and potential customers were:

- **Line of encapsulated,** miniature silicon mesa transistors packaged in cases considerably smaller than the TO18, and expected to be marketed by Texas Instruments later this year.
- **Multiple connectors,** with contacts separated by 0.05 in., to be introduced this year by Amphenol Borg Electronics Corp.
- **Microminiature transistors,** made by Transitron Electronic Corp., to be made available within three months.
- **Microminiature MADT transistors,** by Philco Corp., to be available on sample basis in the fall.

▶ **Shows Outside a Show**—Huge spillover of manufacturers from New York's Coliseum was apparent again this year. IRE show has become too large for the Coliseum with many firms getting inadequate or no display space at all, or not accepting what was available to them, or deciding on other or additional means of reaching 80,000 anticipated registrants. Some companies supplemented their Coliseum displays with private or semipublic lectures on their own products or research, and displayed their wares in hotels around town where they had more elbow room and were away from the hustle and bustle of the Coliseum. Among these "shows away from the show," were Fairchild Semiconductor lectures on its new micrologic circuit elements (AW Feb. 22, p. 75), Burroughs' display and discussion of its Macro Module (AW Mar. 21, p. 67) and Fluxlok programs, Litton Industries' lectures, and U. S. Semcor technical seminars.

▶ **Memory Showing Confirmed**—Thin film memory planes which can store 160 bits and can be incorporated into random access memories having cycle times of 0.2 microseconds were displayed by Burroughs Corp. A 1 mc memory was demonstrated, confirming report (AW Feb. 22, p. 75) that firm would demonstrate feasibility of thin film memory at IRE or Naecon.

▶ **Souvenir Hunters**—Souvenir hunters, swallowing up free literature, promotional material and in some cases expensive equipment, mingled with other viewers at the Coliseum. Varo Mfg. Co. was one victim. The Texas company lost a miniature receiver which it was using in demonstrating a 27-mc. molectronic transmitter.

LANDING RUN on an Alpine glacier usually ends near rocks or a high wall of ice. Takeoff is planned before landing is attempted

Glacier Landing Technique Developed

By Edith Walford

HERMANN GEIGER, Swiss alpine rescue pilot, made his first successful mountain landing in 1952. He learned gliding in 1936 and qualified as a powered flight pilot in 1938. He is 46 years old.

Sion, Switzerland—Demand for year-round airlifts for tourists and skiers in Switzerland is on the increase according to an Alpine pilot who, with his rescue team, has saved more than 220 lives since 1958.

The pilot is Hermann Geiger, one of two Swiss nationals who have pioneered the glacier landing technique. The other is Fredi Wissel, of St. Moritz, a hotelier and pilot of a Piper Cub which made a successful landing on the rugged Corviglia, near St. Moritz, in 1950.

Most of the rescue missions are carried out with Piper Cub and Super Piper type aircraft, but when conditions are more than normally complicated, a Bell 47J helicopter is used. For larger-scale operations, a six-seat Pilatus Porter aircraft will shortly go into service. Possibly a second Porter will be added to the fleet.

Like Wissel, Geiger was well prepared when he achieved his first successful landing on the Kanderfirn in the Bernese Oberland on May 10, 1952. Years of study of the structure of snowbound peaks, the influence of wind and weather conditions in mountainous regions as well as thorough gliding experience and the study of the landing and takeoff technique of birds all contributed to his ultimate success.

One full-time and three part-time pilots work with Geiger on the various assignments from the Sion Aero Club. One full-time mechanic is employed on maintenance work.

Varied Assignments

Assignments include sightseeing flights for tourists, airlifting skiers preferring a flight to the usual lift ride, dropping food, particularly fresh vegetables and fruit, to hotel and restaurants, delivering building materials, machinery or any other urgently required supplies to workmen engaged on dam construction for Switzerland's vast hydroelectric schemes, dropping fuel and food to the Alpine Club's huts, and hay for the stranded and starving chamois and sheep when ice or avalanches prevent them from finding their own food.

The hay is paid for out of some of the proceeds of Geiger's lecture tours and partly by private donations and Government subsidies.

The picking up or delivery of mail, the flying of a doctor or midwife to an emergency case in any isolated mountain village are all jobs included in Geiger's daily work schedule. They are charged on a flight-hour basis of the aircraft used for the individual missions.

Top Priority

But the Alpine rescue of the trapped or injured is always given priority. Like all mountain guides, Geiger is constantly on call for any emergency, on Sundays and holidays and during the normal working week.

He recently added another job to his regular assignments: the transport by helicopter of the special cheeses made on the mountains surrounding Sion to their distribution centers in the valley. Previously, these cheeses were damaged en route down the rough mountain roads by mule or other surface means. By helicopter, they now reach their destination in perfect condition and in a fraction of the time normally required.

Aircraft at Geiger's disposal for these various assignments are the property of the Aero Club. The fleet includes one Cessna 170B, three 90 hp. Piper Cubs, two 150 hp. Super Pipers and one Pilatus Porter aircraft, in addition to one 100 hp. Bücker Jungmann biplane and one Bell 47J helicopter.

The Cessna 170B is used for year-round sightseeing trips to the Nendaz Alp, but more frequently to the popular Matterhorn region (14,596 ft.). Riffelberg/Zermatt is only served during the peak skiing season and Montana and Schwarzberg are the only two resorts served throughout the winter, weather permitting, on a daily basis.

Last winter, Geiger extended these flights to include Scheidegg near the Jungfraujoch, Blumental near Mürren and Lac de Veaux near Verbier. This winter, the ski airlift includes Leysen as well.

Airport Lock

In view of the demand for year-round airlift services, Geiger says he would like to see his own operation extended to many more Alpine resorts. But local authorities have been slow to grasp the value to their tourist trade of such an air service. As yet, little or nothing has been done to provide the small landing areas required, let alone to help promote such an airlift in other ways.

Nor has Geiger yet established any regular tie-in service with Switzerland's main airports, but he can provide flights of this kind on request. The cost of picking up three passengers in the

BUSINESS FLYING

SION AERO CLUB bought the first production model of the new Pilatus Porter in October. After certification the plane will be used for large-scale rescue operations.

ONE OF FIVE first production models of the Pilatus Porter will accompany a Swiss Himalaya expedition to Nepal and will drop supplies and make glacier landings. Bell 47J (below) is used for difficult rescue work, and has been used to deliver supplies to construction sites in terrain where it is not possible or practical to land planes.

Cessna 170B at Geneva Airport, for example, and flying them to St. Moritz is about $110. In the Pilatus Porter, which accommodates six passengers in addition to the pilot, the same flight will exactly double that figure.

Balair of Basle, Alpa Helswiss of Bern, Intropa Flug A. G. of Zurich and the Zurich Aero Club provide either shuttle services or charter flights or both, but so far on a limited scale only. Balair operates Cessna 180 aircraft from Basle Airport to several Swiss skiing resorts and Douglas DC-4 and Vickers Viking charter services to other parts of Europe.

Alpa Helswiss, with six Bell 47G helicopters, flies skiers to Gstaad and St. Moritz from Bern and Intropa Flug A. G., latest competitor among the Swiss charter companies, offers shuttle services for skiers between Zurich and St. Moritz and charter flights to any part of Europe in Cessna 180 and Cessna 310B aircraft. Cost of the Zurich-St. Moritz flight is about $95 or $140 respectively.

Taxi Service

Zurich Aero Club provides a number of year-round sightseeing and aero-taxi services to foreign as well as popular Swiss tourist centers. But, in Geiger's view, there is room for many more services.

The Piper Cub aircraft, the same type with which he achieved his first successes, occupies a special place in his estimation. He uses them for almost everything, including pilot training.

He runs the pilot training courses single-handed. Theoretical instruction is given in a large room set aside for this purpose in the Sion Aero Club's office building. In addition to many Swiss air force pilots, Geiger has trained an increasing number from the Austrian, Italian and Spanish air forces and this year, for the first time, an inquiry has been received from the French air force.

Courses for private pilots—about 10 at a time—are on the increase at Sion and the time is approaching when Geiger will need additional help to carry some of the work load.

Following the Geiger pattern, the Swiss Air Ministry, since 1954, has provided courses for pilot instructors to learn the glacier landing technique. Organized under the supervision of Col. Thiébaud, head of the Swiss Flight Police, the aim is to have a number of skilled pilots capable of carrying out Alpine rescue missions throughout Switzerland.

Geiger's rescue teams are Sion and Diverse Alpine Club members (with search dogs) who, like a local volunteer fire department, work on a voluntary basis. Geiger charges his clients only for the flight hours and not for the time spent in searching and rescuing or giving first aid.

The Super Piper aircraft used, capable of carrying either a patient on a stretcher or a 330 lb. load, or else an adult plus 110 lb. in addition to the pilot, are employed chiefly for the rescue work. To give this plane a higher ceiling, Geiger has removed the starter and some other electrical equipment weighing in all about 65 lb.

Empty weight thus has been reduced to about 1,100 lb. so that the pilot can maneuver the plane into position on the ground unaided. The high wing allows the pilot to land on uneven ground with little risk of damage. Maximum speed is 125 mph., minimum speed 30 mph., and cruising speed, with supply dropping container or skis, 95 mph.

To reduce the Super Piper's engine temperature when heavily loaded and climbing at its maximum rate, Geiger has shortened the exhaust pipe and fitted sheets of aluminum to improve the air stream between the cooling fins. He explained he adapted this procedure from Max Conrad, who crossed the Atlantic in 1953 and 1954—among many other long-distance flights—in a four-seater Super Piper plane.

Porter Operations

Last October, the first production model of the new Swiss Pilatus Porter multi-purpose plane (AW June 15, 1959, p. 101) was added to Geiger's fleet. So far, he has made about 100 successful trial landings with this aircraft. Pending Swiss Air Ministry certification, expected shortly, the Porter is being used for hay-dropping to chamois and sheep.

After certification, the plane will be used for all major rescue operations. Interior provides room for two rescue teams, each made up of two search dogs and their two leaders, and the pilot.

National Distillers' Second Grumman Gulfstream

Second Grumman Gulfstream turboprop executive transport purchased by National Distillers & Chemical Corp., New York, is shown at Westchester County Airport. Corporation's first Gulfstream was delivered last September. Final modification of this Gulfstream was completed by Howard Aero, Inc., San Antonio, Tex.; communication and navigation equipment was installed by Smith Meeker Engineering Co., Teterboro Airport, N. J. Powerplants are two Rolls-Royce RDa. 7/2 turboprops.

plus first aid kit. Without skis, which weigh 220 lb, the Porter's ceiling is 20,300 ft, with skis fitted it is 16,400 ft.

The Sion Aero Club plans to purchase a second model of this type shortly.

More complicated rescue missions usually are accomplished with the Bell 47J helicopter, but it is also used for delivering a wide variety of supplies to workmen in difficult terrain. One example of this kind was last year when tools and other equipment had to be flown to engineers engaged in testing the rock foundations on which to build a new dam on the Aletsch glacier. Work was in progress on the steep slope of a deep ravine.

Supplies were being held up by the difficulty of reaching the spot on foot and Geiger was called in to help. A temporary wooden platform was constructed on iron pile supports driven deep into the rock face as a landing stage for the helicopter. Geiger delivered in one day the equipment that had previously taken about two weeks by mule delivery.

Landing Hazard

The Bell 47J, providing room for the pilot, two stretchers and a doctor or midwife, also is used for various emergency cases where rocks or otherwise abnormally uneven surfaces make it inadvisable to land other aircraft.

The Bücker Jungmann biplane, built by Bücker of Berlin-Charlottenburg, Germany, and produced under license in Switzerland by Flug-und Fahrzeugwerke A. G., Altenrhein, is used for pilot aerobatic training only.

Cost per flying hour of each of the aircraft used is: Cessna 170B, $30, Pilatus Porter, $60, Piper Cub, $15, Super Piper, $20, Bell 47J helicopter, $125, and Bücker Jungmann biplane, $18.

Last year, total hours flown were 3,088 and 5,600 passengers and 153 tons of material were carried. In 1958, 2,900 hr. were flown and 4,000 passengers and 130 tons of material were carried.

Geiger's success with glacier flying was acquired with extreme patience, with the gradual familiarization with high altitudes and with learning to judge from a reasonable height the quality of the snow or other surfaces on which to land.

Alpine Landings

He explained that in the Alps, where most landing areas have no clear run, touchdown must succeed the first time. Here the "runway" usually ends with rocks or a high wall of ice. The technique is to approach at the right altitude, make a fairly short run-in, then touch down and use engine power to taxi the plane to the best spot for takeoff. The pilot therefore plans his takeoff even before he makes his landing.

It is essential to judge the inclination of the slope. As with water landings, it is difficult to estimate altitudes visually.

To do all this, the chosen landing area must be flown over repeatedly from different directions. The approach is a slow glide, checking the airspeed indicator, watching the altitude and adapting to the entire field of view outside the aircraft.

Touchdown Technique

Touchdown is the same as on an airfield if the glacier is level. But when it is inclined at 5 or 10 deg., the pilot must maintain higher speed coming down, then throttle back sharply and put the plane in position parallel to the slope at about 6 to 9 ft. above the ground. Then he lowers the flaps, cutting speed by approximately 15 mph. while maintaining enough lift, and pulls the aircraft up the slope with full power to the spot picked for touchdown.

Now he throttles back, the plane touches down and after the skis have made contact with the surface, he taxis to the top of the slope. He positions the plane at the far end of the space available, because all of it is used for takeoff.

After landing, Geiger secures the plane by letting the tail swing round slightly. The tail wheel, fitted with a small ski, anchors itself in the snow. If the slope is steep, the wheels have to be lowered below the skis and the brakes applied. The engine should be kept idling so that it doesn't cool off too rapidly.

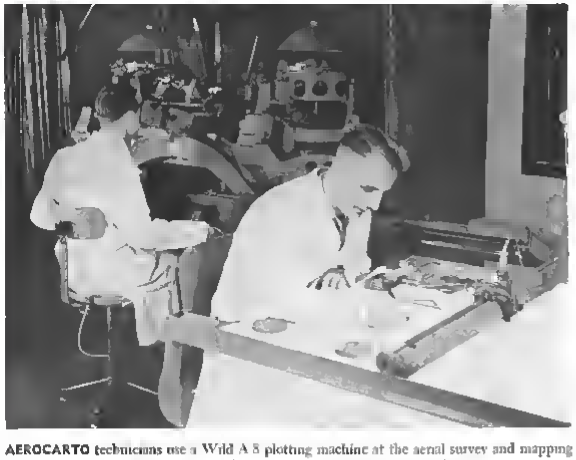
Paces Out Terrain

Geiger then paces out the terrain to judge its length while keeping on the lookout for crevasses. Sticky snow requires that the skis be lubricated which reduces the distance needed for takeoff by about 50%. Because the pilot often has to operate unaided or with an injured person aboard, for takeoff he should pivot the aircraft by moving its tail yard by yard to where it will still hold, oblique to the line of flight. A sudden burst of full power is required for takeoff. The wash of the propeller is strong enough to act on the deflected rudder, which puts the plane into the line of takeoff immediately it begins to slide.

Once the aircraft starts to descend, the stick must be pushed forward to lift the fuselage. The plane is pulled off the ground vigorously, put parallel to the slope again and given full throttle.

TYPICAL of Aerocarto, Ltd.'s, enlargement capability is this blowup of an aerial photo measuring about 13 x 19 ft.

KLM Operates Large Photography Section



AEROCARTO technicians use a Wild A 8 plotting machine at the aerial survey and mapping center at Delft. The men are members of Aerocarto's Cartographic Section.

Schiphol, Holland—KLM Royal Dutch Airlines' photo-technical section KLM Aerocarto, Ltd., is one of the largest and most modern organizations engaged in European aerial photography.

Its fleet of three Douglas DC-3 conversions works chiefly on contracts abroad.

Each has a crew of four: pilot, navigator, cameraman and radio operator or flight engineer. In addition, one Auster 5 and one de Havilland DH 89A Dragon Rapide Mark 3 aircraft are in service in Holland.

Staff Size

Total staff numbers 120. Fifty of these work at KLM's Schiphol Airport base, and 70, in the cartographic section, share a building with the Dutch Ministry of Works' international training center for aerial surveying and mapping at Delft.

The company's library contains more than 50,000 negatives, many of which have historical value. Pictures have been taken over a period of many years for various departments of the Dutch and foreign governments, municipal authorities and industry.

Founded on Nov. 21, 1921, at Waalhaven Airport near Rotterdam, this subdivision of the Dutch airline was first called KLM Photo-technical Section. Its name was changed to KLM Aerocarto, Ltd., in 1954 in recognition of its growing importance and to give it official independent status.

Serious Setback

During World War II it suffered a serious setback from loss of a major part of its photographic equipment including some aircraft.

It had to suspend operations for the duration of hostilities.

First aim of the company after its establishment was to commercialize oblique aerial photography within the Netherlands.

Forty years ago that was a new idea but it caught on rapidly and its tremendous potential economic value at home and abroad was soon realized.

Vertical Photography

Experiments in vertical photography as a new geodetic tool were started in 1928.

Four years later it had been adopted by many government departments for topographic and cadastral mapping purposes, for drawings in connection with highway construction schemes and for river improvements, among many other uses.

Various branches of industry meanwhile had been given proof of the value of aerial surveys for their own specific purposes, particularly in the oil industry.

In 1934 the Royal Dutch East Indies Airlines was asked to map 30 million acres for oil exploration purposes in New Guinea. Work on this gigantic project began in 1935 and KLM's photo-technical section was asked to assist in the project.

Here the company employed its first automatic German Zeiss surveying cameras, which had just become available at that time.

Oil Survey

The experience KLM gained on this contract paid off when the United British Oilfields wanted to expand its oil exploration territory in Trinidad and decided to first have an aerial survey made of the island. KLM obtained the contract in 1937. It was followed by similar jobs in Venezuela, Curacao, Aruba and Dutch Guiana, but most of this work had to be discontinued during World War II.

A restart was made in 1946 in the Netherlands and in Central America where again new cameras, this time made by the Swiss firm of Wild at Heerbrugg near St. Gall, were introduced.

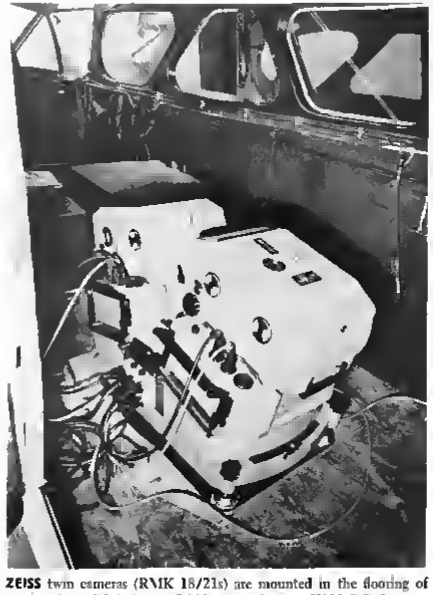
Work on old contracts was also resumed in Venezuela, Dutch Antilles and Dutch Guiana and a new order in French Guiana was added to KLM's long list of other survey missions being executed in Austria, Syria, Iran, Egypt, Thailand and New Guinea.

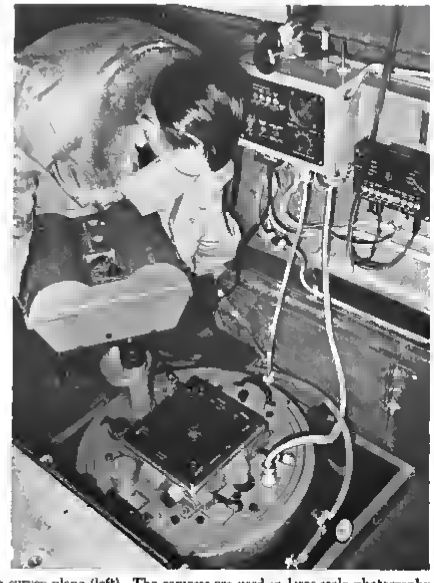
Photographic Scales

Photographic scales varying from 1:1,000 to 1:100,000 have been used by Aerocarto, Ltd., since 1956. Recently, with the introduction of the airborne profile recorder for more accurate surveying of vast areas, medium and small-scale photography of from 1:10,000 to 1:60,000 has been possible.

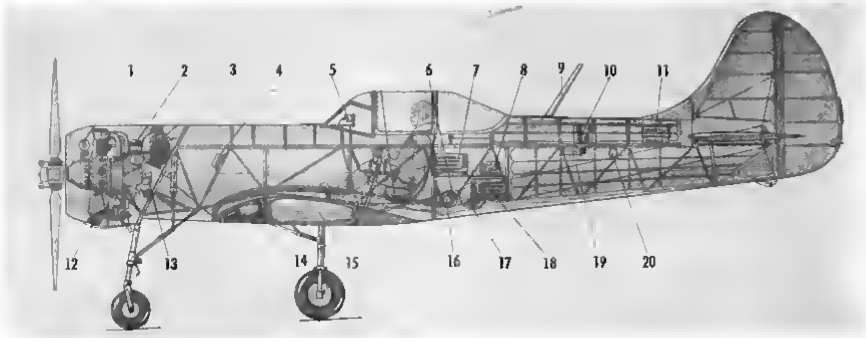
With the use of the latest type Zeiss twin camera with a reduced shutter speed of 1/1,000 sec., greater accuracy in large-scale photography on a scale of from 1:1,000 to 1:5,000 has been achieved by the group.

Steady improvements in photographic material and optics have opened the way to extremely small-scale photography, which in turn is dictating the use of aircraft with a higher working ceiling to carry out the job.

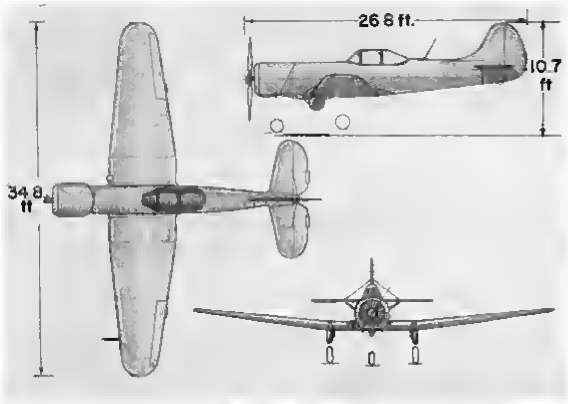




ZEISS twin cameras (RMK 18/21s) are mounted in the flooring of a survey plane (left). The cameras are used in large scale photography ranging from 1:1,000 to 1:5,000. At right is a Wild RC 5 survey camera installed in a Douglas DC-3 transport. Most of KLM's aerial photography work is done abroad on contract.



SOVIET YAK-18P sports plane equipment includes (1) compressor (2) generator (3) oil tank (4) electrical panel (5) compass (6) emergency hydraulic tank (7) radio receiver (8) radio rectifier (9) antenna (10) converter (11) storage battery (12) air intake for carburetor (13) breather oil tank (14) oil cooler (15) fuel tank (16) power supply inlet (17) main hydraulic cylinder (18) transmitter (19) power supply relay panel (20) converter



THREE-VIEW shows partial retraction of main gear centered position of cockpit

Yak-18P Single-Place Sports Plane Performance Detailed by Soviets

Official Russian specifications detailing performance and characteristics of the Yak-18P single-place acrobatic and sports club airplane reveal that it has a sea level top speed of 171 mph., rate of climb at sea level of 32 8 fps., service ceiling of 21,326 ft. and endurance of 50 min. with 15 8 gal. of fuel.

The Yak-18P is credited with a take-off run of 394 ft. and landing run of 656 ft. Landing speed is given as 59 mph. The all-metal trainer has a gross weight of 2,348 lb. and empty weight of 2,024 lb. Dimensions include: span, 34 8 ft.; length, 26 8 ft.; height 10 7 ft.; wing area of plane is 183 sq. ft.

Mean aerodynamic chord is 5 53 ft., area of horizontal tail surfaces is 34 3 sq. ft., area of vertical tail surfaces is 16 95 sq. ft. Two-blade wood variable-pitch propeller is of 7 5 ft. diameter.

A development of the two-place Yak-18A primary trainer, the later Yak-18P is powered by a 260 hp. AI-14R nine-cylinder radial engine. Tricycle landing gear is semi retractable and later models will have fully retractable landing gear. Engine fuel and lubricating systems are designed to permit fully inverted flight up to five-minute duration.

New York Agrees On New Heliport Plans

New York—Plans for a second commercial heliport in New York City were agreed upon by the city's Department of Marine and Aviation and the Port of New York Authority.

New York Airways will serve this heliport as it does the present one at West 30th St. in the downtown to-airport operation to Newark, La Guardia and Idlewild airports.

Agreement covering the new heliport now is before the city's Board of Estimate for approval.

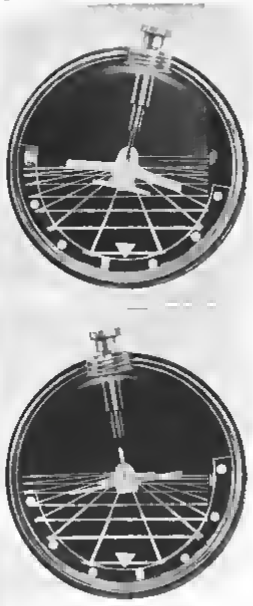
Plan calls for construction by the Port Authority on land leased from the city. Land rental was set at $14,000 for the first year, rising to $47,000 for the seventh year and to $81,500 a year when the permanent heliport is completed. First phase of the project is scheduled for completion in about nine months. The 310,000 sq. ft. site is at the southeast tip of Manhattan Island, in the Wall St. area.

New York Airways' certificate has been renewed for seven more years but was not made permanent because CAB did not feel it was propitious at this time, partly because of the continuing subsidy needs of the helicopter airline. The Board lifted a restriction to rotor type aircraft which New York Airways said was "especially pleasing" and will mean the carrier can use any type of steep gradient aircraft that becomes available.

New points added to the suburban network New York Airways is authorized to serve were Danbury, Conn., and New Haven, Conn. The carrier said plans to serve these points were not yet definite.

3-D Gyro Horizon

Three dimensional gyro horizon for planes with gross weights below 12,500 lb., has been developed by Coffing Industries, Inc., Covington, Ind. Instrument, interchangeable with conventional artificial horizon, shows a tiny three-dimension plane suspended in the center, plane is connected by linkage to the gyro and duplicates positive and negative pitch. Behind the plane is a converging section-line grid depicting the horizon and ground for terrain reference. Knob adjustment at top is used to calibrate the unit. Dots on instrument face show 30 deg. movements.



British Design New Air Cushion Vehicle

London—"Cushion-Craft," British air cushion vehicle built specifically to test commercial possibilities, is under construction at the Isle of Wight.

Made by the Britten-Norman Co., the vehicle will differ in several respects from the Saunders-Roe SRN-1 Hovercraft, but shape, technical details and performance have not been revealed.

Prototype has a maximum diameter of 20 ft., propulsion will be by two variable-pitch helicopter rear-mounted propellers.

N. D. Norman, one of the designers, said that the Cushion-Craft was a few feet smaller than the Hovercraft.

PRIVATE LINES

Coast Rotors Co. will operate its Republic Alouette II turbine powered helicopters in passenger shuttle service from 10 heliports approved throughout San Diego, Calif. (AW Nov. 16, p. 73). Company now has two Alouettes with four more on order. Main base is at Lindbergh Field.

Mooney Aircraft, Inc., is offering buyers of Mooney planes an insurance refund of 10% of the hull premium if a year's operations is completed without claims. Company has written a fleet policy with American Fire & Casualty Co. and each individual buyer will be covered with a separate certificate of insurance. Hull rate will be 4% of the insured value on a new Mooney at its retail value, flown by a pilot with at least 500 hr. total time and 25 hr. in retractable gear aircraft. Deductibles will be $260 for flight or taxi and $50 when not in motion.

Delta Helicopters has been formed at Fairbanks, Alaska, to engage in general charter work, fire fighting under government contract and oil and mining surveys. President is Marvin W. Paul and secretary-treasurer is Garry L. Kinney. The company owns a new Bell 47G-2 Trooper.

Fairchild Aerial Surveys, Inc., has completed a 260,000 mi. mapping survey in Libya, using a Lockheed Lodestar at altitudes ranging from 23,000 to 25,000 ft. Job was done for nine U. S. and foreign oil companies.

Air Taxi Co., Newark, N. J., is offering round trip flights from New Jersey to Aqueduct Race Track, by way of New York International Airport, for $25 per passenger with a minimum of two. Price includes taxi fare to and from the track. Company operates nine

planes, including a new Piper Aztec (AW Jan 25, p 111)

Two Piper Apaches have been purchased by Transco Products, Inc., Los Angeles, Calif., electronics manufacturer. Company also owns a Cessna 172.

Rising trend in private aircraft ownership is evident in Sweden, which now has 438 planes registered, against 120 in 1945. Glider registrations have risen from 81 in 1945 to 187 in 1959.

Koss Construction Co. of Des Moines, Iowa, has replaced its single-engine Beech Bonanza with a new twin Beech Super G18 executive transport. Jim Dolezal is chief pilot. Plane was the 500th in the Super G18 series and was purchased through Elliott Flying Service, Davenport and Des Moines.

British Gliding Assn. Chairman Philip Wills has asked for government support of gliding, citing 157,540 launches and 27,384 hr flown last year. He requested a revolving, interest-free fund of $1.4 million to "ensure the growth and future of gliding and sporting flying."

National Aeronautical Radio Corp. (Narco) will deliver a small, lightweight, low-cost airborne distance measuring unit) for light aircraft to FAA's Bureau of Research and Development by September for testing. After evaluation and acceptance, models will be made available to manufacturers of comparable equipments.

Cessna Aircraft sold 400 commercial planes in February to reach an all-time monthly high volume. Sales of planes, parts and optional equipment totaled $6,532,000. Total sales volume for February were $11,131,000, highest since World War II.

New Convair Averliner demonstrator has been designed by Frederick B. Ayer & Associates in a 17 passenger configuration, fitted with Pratt & Whitney R-2800 engines. Plane will start a national sales tour Apr. 15 at Los Angeles, Calif. Sales price for Convairs in similar configuration will be slightly more than $338,500.

Okanagan Helicopters, Ltd., has purchased two Hiller 12E helicopters for $110,000 delivered at Vancouver, B. C., International Airport. New helicopters bring Okanagan's fleet to 59 aircraft.

Beech Model 33 Debonair (AW Mar. 21, p. 86) is now being offered in a choice of three-color paint designs.

WHO'S WHERE

(Continued from page 23)

Changes

Samuel Feinstein, manager, Applied Research Laboratory of Servomechanisms, Inc.'s Research Division, Goleta, Calif.

Herbert A. Cohen, manager of the newly formed Space Instrumentation Division of Acton Laboratories, Inc., Acton, Mass., a subsidiary of Technology Instrument Corp. Associated with Mr. Cohen will be **Joseph R. Frassora** and **James L. King**.

J. F. Murray, director of engineering, Pesco Products Division, Borg-Warner Corp., Bedford, Ohio. Also, **Thomas D. Carpenter**, manager, future product planning, and **Louis J. Schafer**, project manager. Other Pesco engineering department changes: **Thor Hohn**, manager, engineering design, and **Albert Paul**, supervisor of design.

Armen V. Babayan, manager of engineering services, Chicago Aerial Industries, Inc., Melrose Park, Ill.

Frank C. MacTernan, corporate director of airline support services, The Garrett Corp., Los Angeles, Calif.

Carl F. Schaefer, engineering manager, and **Ernest J. Greenwood**, operations manager, Norden Division of United Aircraft Corp., Stamford, Conn. Other Norden engineering staff appointments: **Frank S. Preston**, chief engineer, **Edward R. Harris**, assistant chief engineer, **Leo Botwin**, chief, engineering operations, **Malcolm V. Lane**, administrative engineer, **Robert D. Rinehart**, chief, component engineering.

Leroy Oliver, chief, technical representative, Vought Aeronautics Co., Chance Vought Aircraft, Inc., Dallas, Texas.

Michael D. Dawson, senior analyst, Management Sciences Division of United Research, Inc., Cambridge, Mass.

Dr. George E. Valley, Jr. will serve as a scientific consultant to Northrop Corp., Beverly Hills, Calif.

Richard A. Gilbert, operating manager, McDonnell Automation Center, newly established division of McDonnell Aircraft Corp., St. Louis, Mo.

Walter A. Scrivens, director of manufacturing, REF Manufacturing Corp., Mineola, N. Y. Also, **Harold Maron**, supervisor of sales-ground support equipment.

Dr. Geza S. Gedeon, now head and research scientist of the Astrodynamics Laboratory, Astro Systems and Research Laboratories of Norair Division of Northrop Corp., Hawthorne, Calif.

James F. Fisher, manager, Flight Safety Division of Hardman Tool and Engineering Co., Los Angeles, Calif.

William Lawrence, director of operations, Electronics Division of Stromberg-Carlson, a division of General Dynamics Corp., Rochester, N. Y.

Beverly W. Hodges, assistant chief engineer, Boeing Airplane Co.'s Wichita (Kan.) Division. Mr. Hodges will have direction of all of the prime technologies. Appointed section heads of the technological sections reporting to Mr. Hodges are: **H. C. Higgins**, aerodynamics and propulsion; **R. E. Watson**, structures; **Phil F. Novak**, electrical and electronics; **B. C. Hainline**, airplane systems and reliability.

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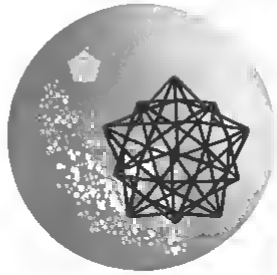

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B-17 Engines as follows: one new 1620-87 at $1,000 and 7 NT3O at $750 each. Each engine sealed in steel container. Complete records. Stinson Field Aircraft, Box 1788, San Antonio, Texas. CA 4-8434.

For sale, progressively overhauled 1st April 1960 fuel cell S. Huron Sarlac II Aircraft being withdrawn airline service. Full radio all essential modifications embodied, good condition, including large banking stock of spares and spare engines. Preferably package deal. Available for inspection at Lagos, Nigeria at any time. Offers as is, Sprinflex Hose available. Apply to Liquidation, West African Airways Corporation, Merlan House, P.O. Box 549, Lagos, Nigeria.

Hiller Helicopters—low time—many spares—dual and spray equip. Prices start each 10,000—will take airplanes in trade. James M. Meade—1670 Willow Dr., Fortuna, Calif.—EA 2-3634.

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ADVERTISERS INDEX

PROBLEMATICAL RECREATIONS 8

An expert on transformer design relaxed one Saturday by going to the races. At the end of the first race he had doubled his money. He bet $30 on the second race and tripled his money. He bet $54 on the third race and quadrupled his money. He bet $72 on the fourth race and lost it, but still had $48 left. With how much money did he start?

—Adapted from Chuquet 1484

Experts on logic design find exercise for their expertise in applications to our large-scale real-time digital computers. Interested? Write to R. W. Robinson.

ANSWER TO LAST WEEK'S PROBLEM: Notice that the given number is equivalent to seven raised to ten thousand divided by seven and that ten thousand is equal to four times twenty-five hundred, then introducing a suitable variable, k, one ends with a two term number. The first term is equal to $10^4(k-1)$ divided by seven and the second term, 143, is the solution to the problem.

LETTERS

Defense Insurance

A Bitter Engineer (AW Feb 15, p 166) uses some very strange logic and displays an unfortunate lack of understanding of the realities of the national defense picture for one who feels compelled to straighten out the public on the matter.

If duplication is waste, it is necessary waste when dealing with defense programs which are less than 100% sure of success but are, at the same time, absolutely vital to our defense. Duplication looks like waste if both approaches work just as life insurance is waste if you happen to live to be 90!

During World War II five different approaches to the problem of separation of fissionable material were all pushed vigorously, and all were successful. Was this "quintication" wasteful? No. We found out which were the best methods and we had more fissionable material by August 1945 than we would have had otherwise.

Our government concluded in 1953 that ICBMs were feasible, and in 1955 concluded that they were so important that a dual program was necessary. Thus we have Atlas and Titan.

Now our "Bitter Engineer" would like to see the government cancel the Titan so Convair could get bigger production orders and he could get a raise. It obviously makes no difference to him that one of the best missile teams in the country would be disbanded that Denver would lose 10,000 jobs, that the only fully integrated development and test plant in the country would be wasted, that the total U.S. capacity for producing ICBMs would be cut in half (whether we assume one, two or three shifts), that the country might discover at any time that it must increase ICBM production to the maximum that earthquakes, tidal waves, or other natural disasters which could wreck a defense plant are quite possible (particularly on the California coast), and that loss of our only ICBM plant could be a catastrophe that sabotage and strikes are also possible that baskets of eggs are sometimes dropped that there would be an inevitable lag in the attainment of the operational hard based ICBMs so important to the deterrence of all-out nuclear war, and that our best counterforce weapon would be gone. The last, in particular, would make no difference to him since he obviously doesn't even know what a counterforce weapon is. If he did he would not consider Minuteman and Polaris better than his own Atlas and would not even think that larger payloads were of no value.

The Strategic Air Command (whose business it is to understand the use of and the requirements for modern weapons) wants larger payloads. And they are not too concerned about "overkilling." They know how hard it is to destroy hardened military bases even with larger warheads than are now carried by our missiles—particularly if you don't know the exact target location within several miles.

Does "Bitter Engineer" know that it takes 27 one megaton warheads delivered with a two mile CEP to knock out a single one hundred psi point target (90% probability), while only six 10 megaton warheads would be required? Does he know the difference in cost involved in developing, producing, basing, maintaining and operating 27 one-megaton warhead carriers as opposed to six 10-megaton carriers?

It is fortunate for the security of our country that the Air Force is not run by people like "Bitter Engineer."

(Name withheld by request)

SOUR ENGINEER
Denver, Colo.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Add this vote for the lads who are opposing the "space race" stampede (AW Feb 15, p 166). A race implies clean cut objectives. Whereas there are known and highly desirable objectives for certain space satellites (weather information, communication relays and the like and those we must have), the "space race" to photograph the reverse side of the moon—get to Venus first and similar projects can be justified only for generalized purposes such as 'man's natural curiosity'—"national prestige"—"exploration."

Remember that Russia is plugging the "space race" for all it's worth. Wouldn't it be the neatest gambit in international relations to get us shooting monsters for generalized purposes when the cost to them is a small fraction of the cost to us? Every time we fire off one of these 'worth-their weight in gold' monsters without a clear cut purpose it cuts back the number of dollars from our national budget of 70 some odd billions. Something has to give. Gen. Trudeau has pointed out economics by stating that it takes the equivalent of 2,000 pairs of shoes to build a Russian tank whereas it costs us the equivalent of 10,000 pairs of shoes.

No doubt such a 5-to-1 ratio in favor of the Russians can't be applied across the board—in fact it seems likely that comparison of costs in the large missile field would be much greater in the Russian's favor since tanks are mass-produced items but large missiles involve much personal babying by large numbers of high paid engineers.

I'm not "against" progress. We must develop space technology which will obviously return great advantages. But, if we weaken our conventional earthbound defense team to dangerous levels we are liable to lose a whole lot more prestige than being second to reach Venus. Let's keep first things first. Russia's written doctrine is to control earth not beat us to other planets. Regarding the letter from 'Bitter Engineer" on duplication. I particularly liked his emphasis on Polaris as the best concept compared with Minuteman. Why do we keep building "fixed address" missile bases inside our homeland when we could put the same missile power to sea in ships now lying idle in mothball fleets and thus:

(a) Shorten range (increasing accuracy).

(b) Reduce the necessity for Russia to hit us at home.

(c) Complicate the enemy's ability to neutralize our alert power.

(d) Reduce expense and utilize ships that are now "sitting duck" targets.

J. E. HART
Monterey, Calif.

Pilot Complaints

Have been reading AVIATION WEEK for quite a number of years, also get to read a few other publications dealing with the airlines and aviation in general. Since I used to be very active in aviation I find the subject still very interesting.

In reading more and more letters to the editor from pilots I am wondering if the pilots themselves aren't keeping the ball rolling to get their opinions and stories to the public; one will write a letter against the group and a dozen or more will then write in their defense. One of the main rules of propaganda reads "Tell a story often enough and people will believe it."

There is one complaint that is in more and more letters—the laying of their job on the line—because regulations require a six months physical and proficiency check. Is it possible they are shirking their job, or are they too busy trying to take over other crew members' jobs; or are the side lines they have too demanding? Each time I read this complaint I get the impression there is a doubt (or fear) in the man's mind that he will not pass it.

Since the above checks have been in the regulations and a part of the job for years, I assume the pilot knew they existed when he chose the job as pilot; why all the complaints—these regulations exist for one purpose: to make air transportation safer and to protect the traveling public.

There is also a trend to assume other crew members' jobs, the pilots have already taken over the professional navigator's job and are after the flight engineer's job and at some later date may want a pilot in charge of the cabin crew. This may be one reason they don't have the time to remain qualified in their job, and complain about the proficiency check.

I suppose this (above) will bring out a letter saying, 'Nobody knows a pilot's problems but a pilot.' Very well, but please list all the so-called problems that seem to be no secret and I believe you will be amazed how many people do understand the problems.

I believe for maximum safety the FAA should require a man at each position and not a "jack-of-all-trades" who is not completely qualified in any position, changing from one seat to another.

The above letter is only my opinion, and I believe just as factual as many I have read—so treat it as such. Thank you.

A. J. WENDT
Airline Passenger
San Mateo, Calif.

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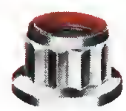

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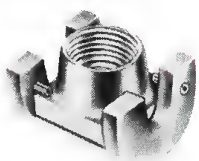

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Photoelastic comparison of stress distribution patterns between standard self-locking nut and modified Elastic Stop nut using the Equa-stress thread form applied to a standard UNF-3 thread. Visual analysis reveals that the load is heavily concentrated on the lower three threads of the standard nut; in the Double Durability nut the load is re-distributed over all of the six threads below the locking device. Send for DESIGN MANUAL 5930 for additional photoelastic studies and illustrative drawings of stress distribution in fasteners.

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